The FOUNDRY

Volume 49 No. 1
Whole No. 362

Published
Semimonthly

CLEVELAND, OHIO, JANUARY 1, 1921

Make Marine Cylinders in New Shop

Practice Pursued at the Boston Navy Yard in Producing a Line of Castings That Must Be Absolutely Perfect in Every Detail of Appearance and Quality

BY HERBERT R. SIMONDS

GOVERNMENT owned plants and those operated for the benefit of or under the direction of the government, while almost always interesting from an operating point of view, usually do not show up favorably when compared on an efficiency financial basis with similar plants owned and conducted as private enterprises. The new foundry at the Boston navy yard is a contrasting case. It has been designed along the most modern lines to secure efficiency in operation. While as yet every single piece of the proposed installation has not been placed in use, all indications point to a system of operation and a class of equipment that will compare favorably with the best modern privately owned foundries. Partly on account of difficulties met in securing deliveries of marine engine castings made by outside interests the policy recently was adopted of building complete fuel ships including all the machinery and equipment within the limits of the yard itself. This policy necessitated increasing the scope of the work handled in the foundry and incidentally was a factor in bringing about the design and construction of a new foundry building. This recently has been completed and placed in service. It forms an extension to the former building, of the same uniform width, and increases the total length by 200 feet. Under the new arrangement the three cupolas have been removed from the foundry proper and set up in a separate building attached near the center to the outside of the side walls. Two cupolas made by the Whiting Corp., Harvey, Ill., have a rated capacity respectively of 4 and 10 tons an hour. The third cupola made by J. W. Paxton Co., Philadephia has a rated capacity of 6 tons an hour. Altogether it is possible, if necessary, to melt 20 tons of iron an hour. The spouts from all three

FIG. 1—COMPLETED 10-TON CYLINDER CASTING FOR A 2500-HORSEPOWER MARINE ENGINE—IT REPRESENTS FOUR WEEKS WORK FOR THE MAN SHOWN ON THE RIGHT TOGETHER WITH HIS CREW OF THREE MOLDERS AND TWO HELPERS

cupolas extend into the foundry far enough to facilitate handling of the ladles by the electric traveling cranes, of which there are three with lifting capacity of 30 tons, 25 tons and 15 tons respectively. The three cranes operate on the same runway, and while it is possible to employ any one of them in any part of the shop, the work is so divided that each crane operates over a fairly well defined area.

Twelve molding machines already have been installed in the new addition and others are in prospect. A combined ventilating and heating system of the most modern type insures an adequate supply of cool air in the summer, and warm air in the winter. The ventilating mains extend high up along the walls. Branch pipes located at 15 feet intervals discharge the air through openings at an approximately 7-foot level. Other features of interest in the new building include a 30 x 30-inch jolt, rollover molding machine, a 12 x 12 x 10-feet deep casting pit in which to set up and pour the heavy and massive castings, and a number of side wall jib cranes designed to supplement and relieve the traveling cranes of a great deal of detail work.

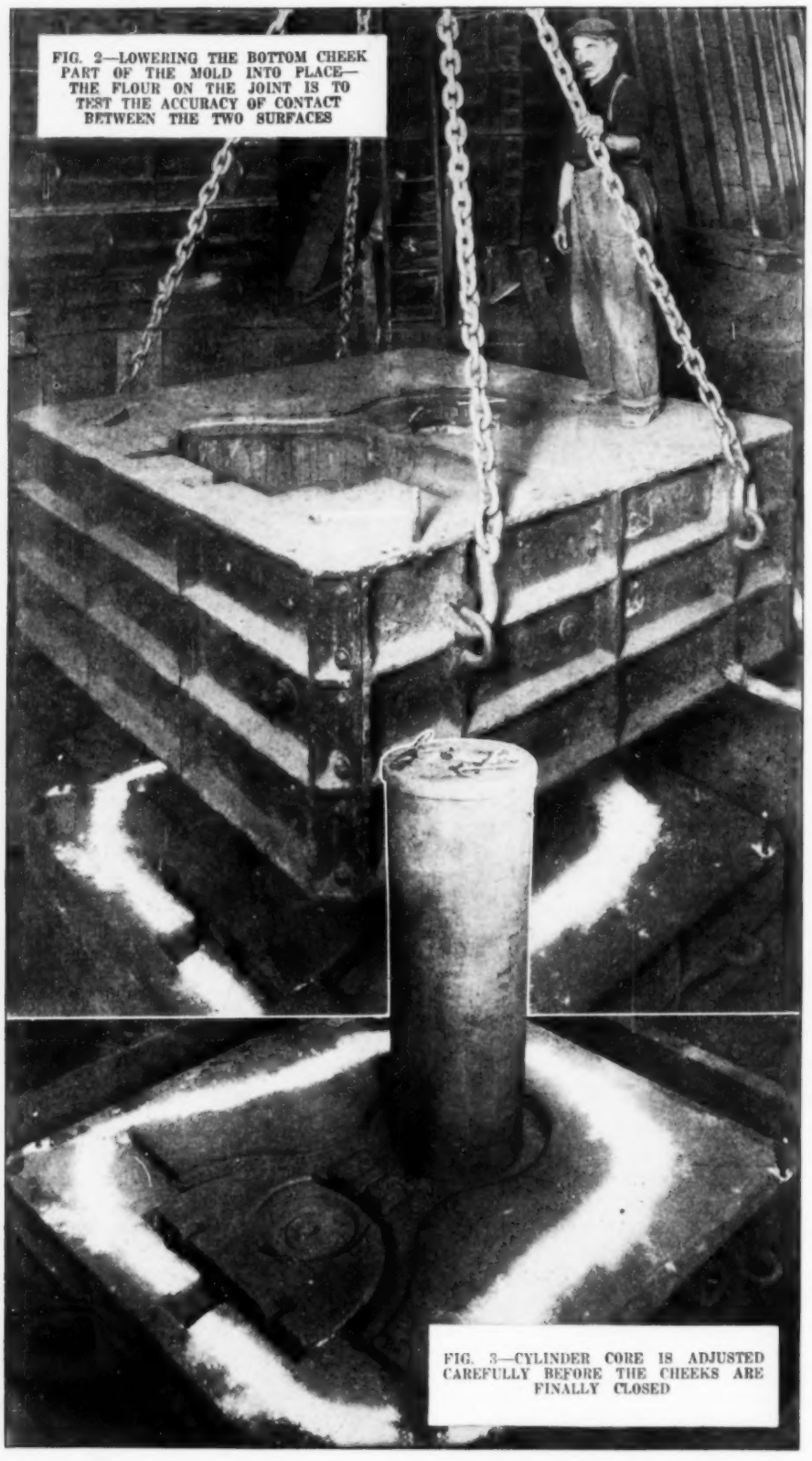


FIG. 2—LOWERING THE BOTTOM CHEEK PART OF THE MOLD INTO PLACE—THE FLOUR ON THE JOINT IS TO TEST THE ACCURACY OF CONTACT BETWEEN THE TWO SURFACES

FIG. 3—CYLINDER CORE IS ADJUSTED CAREFULLY BEFORE THE CHEEKS ARE FINALLY CLOSED

The yard engineering office prepares blue prints for any work to be performed at the foundry. Authorization to do the work is carried on a job order form with an order number, which accompanies the work throughout its entire progress through the plant. Duplicate blue prints and order forms are sent to each of the departments interested. The next step in the sequence of operation after the blue prints have been distributed, takes place in the pattern shop. After the pattern is completed, it is provided with the necessary identifying tag and sent to the foundry. Here, under the supervision of the master molder, R. McKeown, the work is laid out and the patterns and coreboxes checked against the blue print. They also are examined to see that they will function properly and according to correct foundry practice. It has been found necessary in the past, occasionally, to return a pattern that did not conform to these conditions and this has suggested the advisability of closer co-operation between the pattern shop and the foundry. As a result, part of the operating program of the new plant includes frequent conferences between the men in charge in these two shops.

Large Cylinders

One of the first jobs undertaken by the foundry in connection with the construction of complete ships in the yard, was the casting of cylinders for six, 2500-horsepower, triple-expansion, marine engines. As each engine has three cylinders, the total of 18 cylinders gave the job some of the characteristics of repetition work, a factor which undoubtedly exercised a considerable influence on the gratifying results which attended the production of these castings.

It is the custom at the foundry of the Boston navy yard to place an experienced molder in charge of each large job and provide him with as many molders and helpers as seems to be advisable. In the case of this cylinder job, the crew comprised four molders, including the man in charge and two helpers. With this crew, the high pressure cylinder mold required three weeks to complete, the intermediate cylinder mold was made in four weeks, and five weeks were occupied in preparing each mold for the low pressure cylinders. The

respective castings weighed 7½, 10 and 15 tons.

The routine of work incidental to molding, these castings in this particular foundry may best be shown by taking the case of one high pressure cylinder and following it through from start to finish. The three cylinders of one engine are similar in design and construction, the principal difference being in size. However, in the high pressure cylinder, the core construction differs somewhat from the intermediate and low pressure, and as the high pressure cylinder has to withstand a greater working pressure than either of the others, correspondingly greater care is exercised during the molding and casting operations.

This cylinder is to withstand a steam pressure of 200 pounds per square inch when in service, and must pass a hydraulic test of 300 pounds pressure per square inch before it is accepted. The iron used in its construction ordinarily is termed semisteel, which means that in this case 25 per cent steel scrap is charged in the cupola. A tensile strength of 35,000 pounds per square inch is required and it is up to the foundry to meet this rather than any given analysis. In starting to make the mold the leading molder selects a suitable place on he foundry floor on which to place the roll-over board. The lower section of the pattern is set on the board followed by the drag part of the flask which is then rammed full of sand and rolled over. A quantity of coke then is rammed directly under the large vent from the main core and also under any pockets in the pattern that require to be vented freely. Suitable passages are provided between the coke bed and the holes in the bottom plate to carry off the gas and steam. The mold is made in a 4-part flask made up of a drag, two cheeks and a cope. The cheeks are provided with a number of iron bars to carry the sand.

The molds are faced with a mixture of Jersey fire sand, two parts and Lumberton sand, one part mixed in a centrifugal mixer with one part of flour to 12 parts of sand. The facing sand is now wet down with molasses water. Formerly stale beer from one of the nearby breweries was used. The sand mixing room is situated at one end of the foundry and the mixed sand is conveyed to wherever it is required in specially constructed buckets suspended from the overhead cranes.

After the complete flask has been rammed up, the cope is lifted off and turned over. The cores shown standing above the face of the mold in Fig. 5 are attached by wires which extend through the cope and are drawn tight at the back. The face of the mold is then carefully gone over and finished including the nailing of the flanges, as shown in the illustration. It then is given a coat of black wash and shoved into the oven.

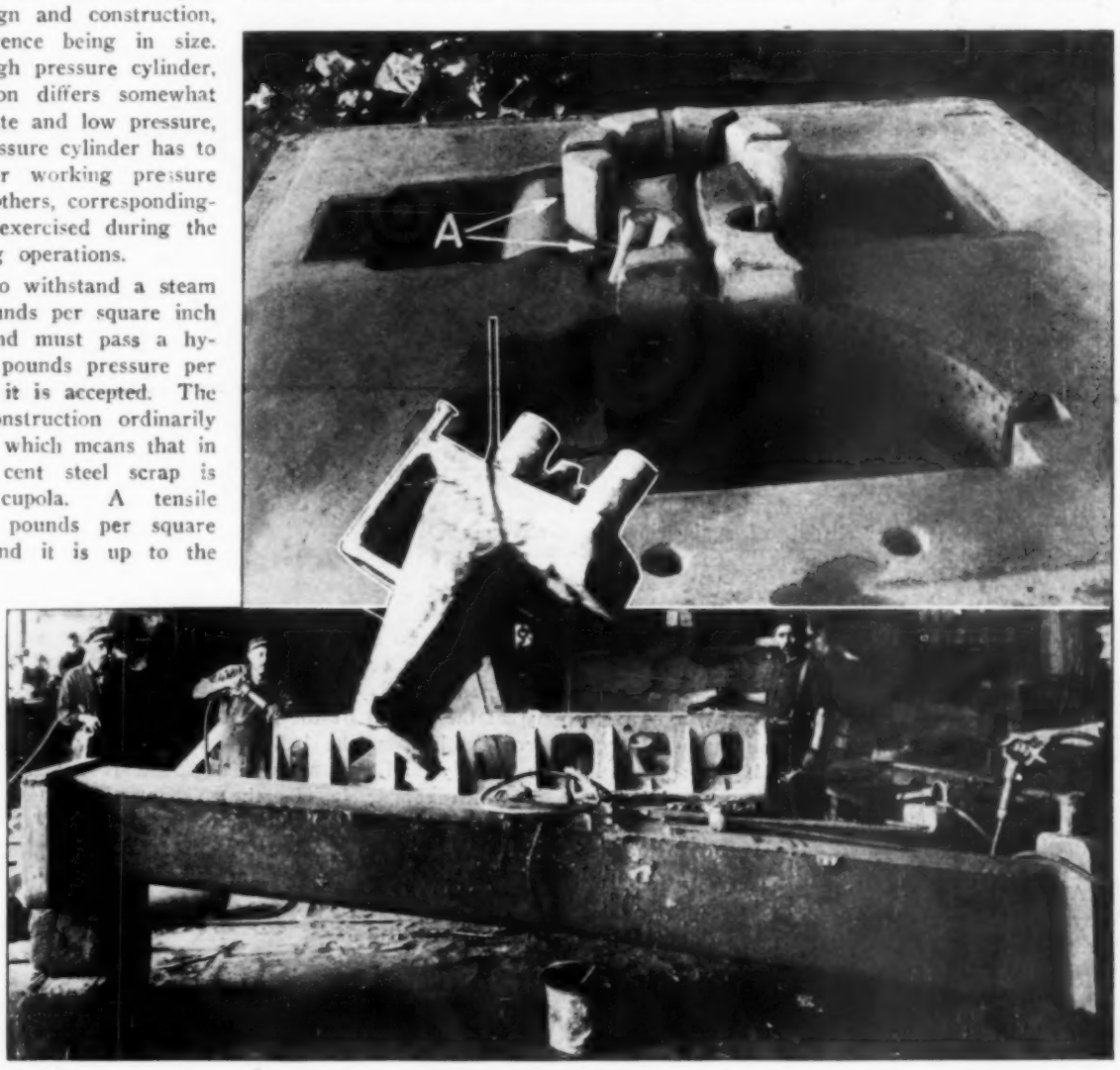


FIG. 4—ONE OF THE CAST IRON ENGINE COLUMNS FOR THE U. S. S. PECOS IS SHOWN IN THE FOREGROUND—THE GIRDER IN THE BACKGROUND AND THE ROLLER BRACKET SUSPENDED FROM THE CRANE ARE STEEL CASTINGS FIG. 5—ABOVE—THE COPE AS IT APPEARS BEFORE IT IS TURNED OVER PREPARATORY TO CLOSING THE MOLD

Oven Is Temporary

The top half of the pattern is drawn and then the top cheek is lifted off. It is set on a pair of horses and after it has been finished and blacked, it also is placed in the oven. The lower cheek is treated in a similar manner. The drag is the last part to be finished. The surface of the mold is nailed all over and two gates are cut, one on each side, connecting the mold with the upright runners. The drag, of course, also is dried.

The oven at present in use, is only temporary. It will be replaced by three electrically operated ovens, which are included in the extensions and improvements already referred to. The temporary oven measures 12 x 16 x 18 feet, burns coal or coke under forced draft and develops a temperature of approximately 800 degrees Fahr. The cores and molds are left in the oven at this temperature for about 12 hours, which has proven to be sufficient for drying any mold or core so far made in the foundry.

After the various parts of the mold and cores are dried, they are taken out of the oven and assembled. A space is cleared away at the bottom of the casting pit, and the drag is lowered down and leveled. The main barrel core is then set approximately upright. The lower cheek is then lowered into place and acts as a guide in locating the bar-

FIG. 6—AN INTERIOR VIEW OF THE TEMPORARY DRYING OVEN

rel core. After it has been adjusted accurately, the cheek is lifted off again and the clearance around the main core print is packed full of sand, black washed and dried with a torch. The other cores are then set, followed by the cheeks and the cope. To provide against a runout or other accident, a large empty flask is placed around the flask containing the mold, and the space between is rammed full of sand. The top of the completed mold is approximately flush with the foundry floor.

Bracing the Flask

As an insurance against accidents of any kind, the upper flasks are braced from the sides of the pit by means of a number of I-beams and angles. The master molder's reason for this apparently unnecessary precaution, is that after a month of preparation, there is no excuse for an oversight in detail which migh result in a lost casting.

A great deal of the work in the navy-yard foundry which possibly could be made in green sand, is made in dry sand; but the cylinder casting shown in the accompanying illustrations is of such a character that a dry sand moid is imperative. When pouring the mold the initial drop of metal is so great that every precaution must be taken to prevent it from cutting the face of the mold.

When the entire mold has been assembled, clamped and braced, runner and risers made up, core vents checked and the whole unit inspected thoroughly, it is ready for the molten iron. A 10 ton ladle is employed for pouring the high pressure cylinder. The runner box connects with two down gates, which in turn, deliver the iron through two gates cut at the bottom of the valve chamber. The runner box also extends in over the center of the flask, and connects with a number of pop gates set around the edge of the barrel core print. The ladle is tipped gently at first, and a small stream sent down the two long runners. After about 2000 pounds are poured in this manner and it is certain that the bottom of the mold is well covered with iron, the ladle is tipped more rapidly and a stream of iron sent in which completely fills the runner box and keeps the pop gates in the center choked, until the iron shows in the risers. The force of the stream is then slowed down until the risers are filled and allowed to flow over. The risers are about 18 inches high, and 5 inches in diameter. After the ladle has been taken away, a man is stationed at each riser and feeds the casting for about half an hour to prevent shrinkage or possible checks in the casting.

The bolts and braces are slacked off after the casting has set, but the mold is not disturbed for four days. The flasks are then stripped off and the casting picked up by the crane and carried to the cleaning room, where the cores are knocked out, after which it is sand blasted, chipped, cleaned, and finally taken to the machine shop.

One of the intermediate cylinders is shown in Fig. 1, cleaned and ready for the machine shop. The man shown alongside the casting has had charge of the group in the preparation of the mold, and as the picture indicates, he takes a pardonable pride in a casting which has occupied his thoughts and his full time for a month.

While the cylinder castings require more care than most other castings that enter into the mechanical equipment of the boats now building at the navy yard, there are other castings subjected to greater strain and requiring considerable attention in their construction. One of these is shown in Fig. 7, which was taken on the steel molding floor. The mold shown in the foreground is for a marine engine girder. One of the cast-iron marine engine columns is shown in the foreground, Fig. 4. A steel casting is shown hanging from the crane in the same illustration.

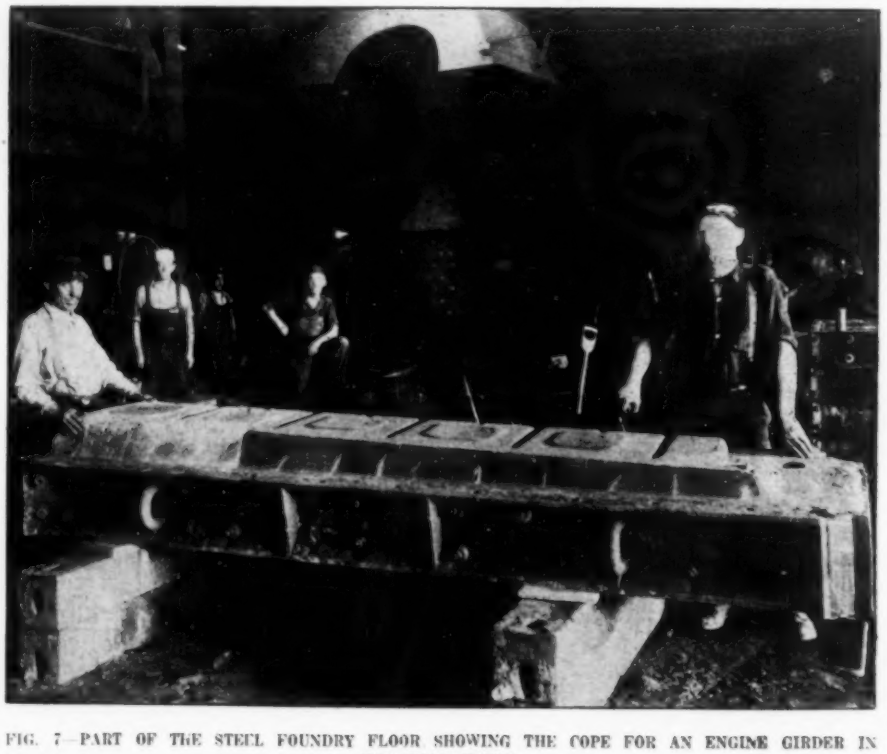


FIG. 7—PART OF THE STEEL FOUNDRY FLOOR SHOWING THE COPE FOR AN ENGINE GIRDER IN THE FOREGROUND

British Brass Foundry Shows Growth

From a Small Foundry Having a Total Output of 5 Tons a Week the Production of the Shop Has Been Raised to an Output of 80 Tons a Week

BY H. B. WEEKS

PREVIOUSLY to the early seventies, brass founding was practically unknown in Barrow. Its industrial birth synchronized with the commencement of operations by the Barrow Iron & Steel Shipbuilding Co. about the year. 1871, that is nearly fifty years ago. The brass foundry then consisted of a small and very badly ventilated shop the dimensions of which were about 30 x 120 feet. Twelve crucible fires were contained, and one reverberatory furnace of 5 tons melting capacity, with a total output of 5 tons per week. In 1897 the Vickers firm took over the control of the works, and work of every description was done.

The present foundry consists of two bays each 310 feet long by 45 feet broad by 40 feet high; another bay 189 feet long by 64 feet broad and 40 feet in height; a fourth bay 187 feet long by 32 feet broad and 28 feet in height. The atmospheric capacity of the building is approximately two million cubic feet. One side of the roofing in each of the main bays is of glass, through which a clear light is obtained. There are also large glass panels in the west side of the foundry, and louvres, running the full length of the several bays, ensure a comparatively pure atmosphere.

Molding operations are served by two overhead electrically-driven cranes, each of 15 tons lifting capacity, and two similarly operated cranes, one of 10 tons and the other of 5 tons lifting capacity. Erected at suitable positions in the shop are eleven hydraulic jib cranes, each with a lift of 3 tons; these are exceptionally suitable for the work they are required to do, as their operating involves no special degree of skill in manipulation, and they can be worked by boys.

Situated at different parts of the foundry are eleven drying stoves, which are heated by producer gas.

The metal-melting plant consists of two 7-ton and one 5-ton reverberatory furnaces, and forty-four crucible fires, the total capacity being 42 tons per day metal output, not production of castings, which is about 40 per cent less. The range of flask equipment is most extensive and covers every requirement of the molding industry. Extensive preparations are at the moment being carried out to permanently take over a space outside the entrance of the foundry for their storage. All requirements by molders for their usage in the foundry will be served by an overhead traveling crane of exceptionally wide span, and which will fully cover the space referred to.

It is common knowledge among foundrymen that systematic treatment in the direction of shop tackle of every description is absolutely essential in the foundry, it being one of the keynotes of production. In order to afford quick access to pattern plates by the plate molders, large racks are built up to the shop walls for their systematic storage during any waiting period before or during manufacture. These racks contain numerous plates, and are divided into portions, each holding plates requiring a different method of attention, as, for instance, dry-sand or green-sand manufacture.

Served by Railway System

The foundry is well served by the works railway system, having two sets of rails entering the shop. One of these takes the consignments from the dispatch department, and the other serves the spaces for wood, coke, and metal storage. A line also runs parallel the whole length of the foundry, in connection with sand deposits, scrap bins, pig beds, etc. The pig-running beds are situated outside the building, thus keeping the heat, fumes, steam, etc., away from the shop. A special portion is set apart in the white metal plant for the filling of bearings, and all such natures of repair to the works plant.

So far as the production of metal is concerned, which includes the making of all the alloys used and the supervision of the subsequent melting for casting purposes, this is all controlled from the chemical laboratory. The chief chemist and metallurgist also advises upon all purchases of raw material. He has control of the melting and mixing of all metals and their heat treatment, as well as of the physical and chemical tests to which the finished products are subjected.

The system applies to all foundries—steel, iron, brass, bronze, aluminum, etc.—in each case the man in charge of the melting and mixing is a trained metallurgist on the chief chemist's staff. Work of an experimental nature is constantly in operation and has resulted in the production of a number of special alloys, suitable for numerous purposes. Among these may be mentioned what are now known as "high-strength brasses," but which were formerly called "manganese bronzes," upon which Messrs. Vickers were one of the first to experiment. These experiments led to the production of a "high-strength brass" that was stronger and more able to resist corrosion than most other similar bronzes on the market. This was a "high-strength brass" of the 60:40 type containing 2 per cent of nickel and about 3 per cent of manganese. The tests from sand castings gave 15 tons per square inch yield, 32-36 tons per square inch tensile, with not less than 15 per cent elongation in 2 inch. This material was somewhat pale in color, however, which was the cause of further experiments being made to produce a bronze of richer tone. Although this was successfully accomplished, it became increasingly difficult to meet the government demands for higher strength and yield point without resorting to arificial cooling of the test bar.

Recognizing that such tests did not represent any portion of the casting, other mixtures were experimented with until one was obtained which fulfilled all the Admiralty requirements for a bar cut from any part of the casting. There is now no difficulty in obtaining from such a casting 20 tons per square inch yield, 40 tons per square inch ultimate tensile strength, and 20 per cent elongation in 2 inches.

Another special alloy that was manufactured here for many years is known as "Vickers Crown Metal," which has the appearance of German silver, and has been found of great value in cases where resistance to corrosion was essential. This also has a yield of 20 tons per square inch, an ultimate tensile of not less than 35

From a paper read at a meeting of the Institute of Metals in Barrow-in-Furness, Sept. 15, 1920. The author, H. B. Weeks, is connected with Messrs. Vickers, Ltd., Barrow-in-Furness, England.

tons per square inch, with about 10 per cent elongation in 2 inches. This has proved of the utmost service for many parts of submarines and their engine fittings.

Much experimental work has also been done on white bearing metals, and a number of white bearing metal troubles experienced by some of His Majesty's ships while on service have been investigated and overcome.

It will be of interest here to record generally that the results of such investigations and the conclusions arrived at, which have proved to have been correct in subsequent practice, have been corroborated by the exertions of other workers who have been good enough to publish their results in the proceedings of this Institute.

A large amount of experimental work has also been done on aluminum alloys suitable for pistons for internal combustion engines. For many years, castings of an aluminum-zinc alloy have been made, giving resistance to tensile stress of about 20 tons per square inch, but with practically no elongation. Such castings have in many cases replaced cast iron with advantage. A large number of aluminum alloy castings have also been produced during the war to air board and other government specifications. In all such operations, the control of pouring temperatures has been of the utmost service, and our experience has again corroborated the results that have been obtained by the Institute's investigators, who have published their results.

Under Scientific Control

It will thus be seen that every endeavor has been made to work the foundry under scientific control, and it is satisfactory to be able to record how interdependent theory and practice have proved to be and how well theoretical investigations have been borne out in practice. This is as it should be. If theory, as applied to practice, is not borne out, there is something radically wrong with either the theory or the practice.

Many members will know that the alloy known as "duralumin" was first investigated at Barrow in this country, and its production has been of great service in the aeronautical world.

A few figures regarding the quantity of castings made during the five years covering the war period may be of interest: Total output of castings from brass foundry, 16,886 tons; largest casting, 23 tons 10 hundredweight; smallest casting, one ounce; total average of rejections for the five years, 3 per cent.

When it is considered that the whole of these castings have been made to governmen specifications, and in numerous cases, in addition to the ordinary physical tests, have had to withstand high water pressure tests, and also in many cases have required to be machined all over without showing any visible defects, it will, we think, be conceded that the above figures constitute the best proof available indicating the success that has attended the system adopted.

Control of Metal

One of the most important items is that of metal control, which is probably the predominant factor in the successful working of the foundry. Where there is a turnover of many tons per week, the greatest care must be exercised in order to avoid mistakes; and the metals, in whatever form they may be, must be perfectly controlled, not alone in the foundry, but also within the different machine and fitting departments where castings are sent. In the weighing-out department connected to the foundry all material is weighed under supervision—that is, in addition to the workman whose duty it is to weigh the metal, the weight is also checked by another workman before it is transferred to the foundry. In the foundry there is placed before each crucible fire an iron tray into which each full charge is placed. The trays are there to prevent any portion of one heat being accidentally conveyed into a neighboring heat and adversely affecting the composition of the alloys.

Scrap metal is not used a second time for the purpose of pouring into molds; it is collected in the foundry and cleaning room, carefully separated, and placed in its own denomination It is melted down into heats, each heat being given a registered number, and is subsequently analyzed before being released for foundry use.

All the high-class alloys or specialties are treated separately, and the scrap melted down to ingot form in plumbago crucibles in coke fires. Not only is the scrap from the various alloys kept separate and distinct in the foundry, but also throughout all the machine departments to where nonferrous metals are dispatched the same great care is exercised in isolating the numerous alloys.

No better vindication is necessary of the accuracy in which all scrap metal from the machine shops and foundry is dealt with than the fact that from analytical tests subsequently taken only very slight variations occur from the specified alloys. A list of the alloys in use, each being given a distinguishing mark or letter for purposes of identification, is available containing the physical tests or composition, and copies are filed in drawing-offices, pattern shop, and foundry. Remarks based on foundry experience were added for the guidance of the drafting room, in order to keep the designer in touch with the metallurgist and enable him to take advantage of any specific properties of a given alloy.

During the process of melting the metal in the crucibles, great care is exercised to prevent oxidation, and charcoal is used to cover the metal, while a metal foreman is constantly in attendance, working under the personal supervision and instructions of the foundry chemist and metallurgist. Particular care is taken that the immediate area of the fires is kept clean and quite free from all scrap, and each fire-hole is fitted with a large cover, so that the metal is in an enclosed chamber during the melting process. Four of the crucible fires can be attended to by one furnaceman. The careful attention given by the workmen, qualified by efficient supervision, has done much to render the brass foundry as nearly immune as possible from the metal troubles so common to the industry.

Furnaces Charged With Briquets

There are, as already stated, forty-four crucible fires of a modified "Carr" type which are operated under good conditions, and which, we believe, have contributed in no small measure to the success we have achieved. They are served by two hydraulic jib cranes each of 5 hundredweight lifting power, and each with an arc radius of 30 feet. Plumbago crucibles of 300, 200, and 150 pound holding capacity are used, and are handled with dexterity by the experienced men in attendance. Apart from the crucibles, there are ladles of 8, 5, and 3 tons, also a number of smaller type. The skimmings from crucibles, ladles, etc., are carefully gathered up and taken to the washing department, when, after separation, they are taken to the reverberatory furnace to be melted, one of the cast pigs from the melt of 5 or 7 tons being later drilled for analysis, in order to determine its composition for later use. The furnaces also are charged with briquets, composed of turnings and borings of every descriptions and form of brass scrap compressed by hydraulic pressure in a special machine provided for that purpose. The principal advantage claimed for the briquetting process is that it facilitates charging the material into the furnace.

Most of the patterns are mounted on plates. This has proved to be a

most economical method, even where there is not any lengthened period of repetition work; patterns with quite a limited number required from them can be profitably put on plates, and economies effected, both in pattern shop and foundry. The system has been applied here to such an extended degree that there are now twenty thousand mounted for the brass foundry alone.

When the patterns are assembled on the plate ready for securing, the foundry foreman decides the position of the gates, runners, and risers. The patterns, gates, etc., are then securely fastened on the board or plate, and if any further instructions are necessary for the guidance of the workman they are usually typed on the plates, thereby ensuring a continuancy of the method established, no matter to which molder the work may at any future time be entrusted. Moreover, in many cases, only one-half of a pattern need be made and mounted on the plate, as this can be set with such accuracy that both bottom and top halves of the mold can be made from it. The practice in the foundry is to have all the molding-boxes drilled to jig, so that the boxes in their own class may be interchangeable. These boxes, made in various sizes, are assigned a special denomination to distinguish them from each other, and the same denomination is engraved upon the plates, so that they can be readily recognized. When in the hands of the molder, he may probably ram up a dozen bottom parts before he starts with the tops, all the time only using one set of guide pins, dropping them through the slots in the molding box into the holes in the plate, thus keeping them in relation with each other until the box is rammed up and the plate withdrawn from the box. The same process is adopted when placing the top half of the mold on the bottom half. As there are only four-thousandths clearance on the pins, it will readily be understood how accurately the parts must register when placed together.

Foundry Procedure

If we follow a loose pattern from the moment it reaches the foundry until the casting is dispatched to the machine shop, it will be both explanatory and instructive.

In the receiving department a complete record of the details of the pattern is made. If no core is required in the molding the pattern is immediately taken into the foundry to go in hand in due course. Should cores be required, however, the core-box is put into the hands of the foreman coremaker. We will assume, then, that the pattern is one for which cores are necessary, and that the core-box has reached its destination. The foreman molder sees the pattern, and decides whether it shall be made in "dry" or "green sand."

In order to follow a pattern offering the furthest insight into the method of procedure, we will assume that the pattern under consideration is to be treated in "dry sand," and has been therefore handed to a molder used to that type of work.

The "dry-sand" molder to whom our pattern has been given, takes the order ticket from it, to enable the card-writer to make out and give him his card for the job, preparatory to the rate-fixer's visit, regarding the basis time to be given for the work in question. The card-writer at the same time enters the name of the molder and the date and time of the commencement of the job on to the order ticket; this is then sent to the head-foreman's office to be entered in their books for the purpose of official progress. The order ticket bearing the molder's name is then forwarded from there to the dispatch, its receipt at this department intimating that the job is passing through the foundry and may be expected. Meanwhile, the molder has commenced operations on the pattern, and it will be necessary to assume that an interval has elapsed, that our mold has been made, and is now ready to be lifted on to the stove carriage to go through the drying process. It will be remembered, in connection with the pattern, that the core-box was taken charge of by the foreman coremaker; of this we are reminded by his arrival with a tally or ticket bearing the name of the coremaker who has made the cores, from whom they may be obtained by the molder when the mold has been drawn from the drying stove, which we at this time will suppose has been done.

It is a regulation that each foreman must send in his application for metal on a printed duplicated form, verbal orders not being permissible. The foreman has ordered his metal for the mold in compliance with this; the necessary quantities have been weighed, checked, and wheeled to the crucible fires, to be put into the pots for melting and then filling the mold. This has been closed by the molders so as to be ready at about the same time as the metal. Our mold is eventually cast, and allowed to cool.

Occasionally when conditions warrant, molds are made in loam. Castings or rather billets of cylindrical contour and solid content destined for forging are poured in chills.

After the molds are taken apart the castings are checked by an over-looker and transferred to the fettling or dressing shop where the cores are knocked out and the risers and gates removed by the saw men.

Keep Casting Record

Further attention by the dresser and, later, sandblastng, will finish our casting, ready for handling by those who are mainly concerned in its dispatch from the foundry. It might here be remembered that the order ticket for the casting had been forwarded from the head-foreman's office to that of dispatch, and that its receipt there would intimate the later arrival of our casting. The casting is weighed, the figures entered on the order ticket, and a label on to which the same details have been entered is affixed to the casting, after which the order ticket is released for commercial attention where, should the order be completed, it will be retained.

Electric riddles and sand-mixing machines are placed within easy access, and workmen are kept busily employed feeding the hopper of the machines, while the sand already treated is being removed by the molders.

Portable mold dryers are also in use to skin dry "green-sand" molds of heavier nature for castings of extreme urgency, and are of great assistance in that direction.

It may be of interest to note the introduction of the Premium Bonus System, which, to judge by results presently obtained, undoubtedly encouraged production in all departments of the foundry. Its value was and is still considerably enhanced by the intelligent co-operation of rate-fixer and foreman in its application, evidenced by the satisfaction with which the scheme has invariably been received by the workman.

To Establish Branch Office

J. F. Webb, manager of the molding machine department of the E. J. Woodison Co., Detroit, during the past three years, will establish a branch office and warehouse of this company at Davenport, Iowa, on Jan. 1. Mr. Webb before his affiliation with the Woodison Co., was employed in an executive position in the foundries of the Bettendorf Co., Bettendorf, Iowa, and the Davenport Locomotive Works, Davenport, Iowa.

Builds Addition to Plant

The Somerville Iron Foundry Co., Somerville, Mass., has practically completed work on the erection of the addition to its plant. This building will be used for storage purposes only.

How To Make a Perfect Belt Joint

The First and Most Important Consideration in Joining the Ends of a Belt of Any Description Together Is To See That They Are Cut Perfectly Square and True

BY F. D. RICH

CUTTING the ends of belt to put it into service, seems such a simple thing that often the belt man does not give it the consideration necessary to insure the best results, and much of the difficulty with otherwise good belts is due to their not being cut and jointed accurately. When a belt runs *wobbly* or races back and forth across the pulleys, it is not giving its best sevice nor can it have its longest life. If a belt is repeatedly jumping off the pulleys, its life is being shortened, power is lost and production is hampered. Provided that its ends are cut square and it is joined with care, a belt can be made to run as straight as an arrow, if the pulleys are lined up true. Don't guess at cutting belt ends. Use a square—always—and use it with care. If a square is not used, one or both of the ends will be cut unevenly or irregularly, which prevents smooth running. Even the use of a straightedge does not assure the perfect results obtained by using a square for the slip of a fraction of an inch will bring the belt ends together at an angle, as shown in illustration Fig. 1.

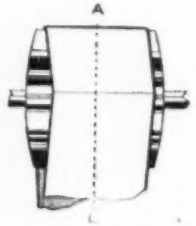


FIG. 1—A BELT JOINED IN THIS MANNER CANNOT RUN TRUE

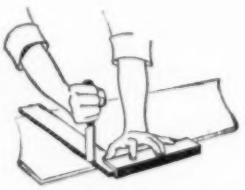


FIG. 2—HOLD THE SQUARE TIGHTLY AGAINST THE EDGE UNTIL YOU HAVE CUT ALL THE WAY THROUGH THE BELT

FIG. 3—TWO NAILS DRIVEN INTO THE BLOCK MAKES SQUARE CUTTING EASY AND POSITIVE

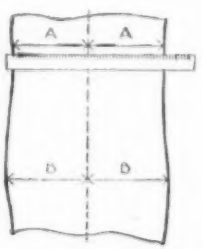


FIG. 4—METHOD OF FINDING THE CENTER OF THE BELT

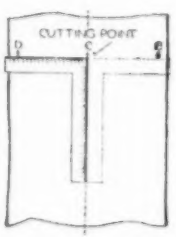


FIG. 5—THE CUTTING LINE IS FOUND BY APPLYING THE SQUARE TO THE CENTER LINE

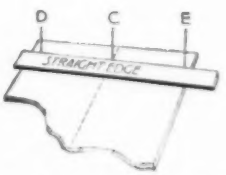


FIG. 6—IT IS ADVISABLE TO USE A STRAIGHT EDGE ON WIDE BELTS

This results in the belt *shimmying* on the pulleys, which is bad for the belt and impairs its service, for as it moves from side to side, the line of direct pull, *A-B*, moves from one side of the belt to the other, imposing shifting and irregular strains, which no belt can stand indefinitely.

There is only one way to assure correct results. That is to use a belt square and to keep it in place until the belt is cut all the way through. Don't just scratch the surface and then hack through. Cutting to the square assures an even cut all the way through the belt and all the way across. It means that the belt ends can be brought together in a tight, butt, evenly-running, flush joint.

For belts up to 15 or 18 inches wide, use the ordinary square. Press it firmly against the edge of the belt and, when cutting, hold the knife vertically as shown in Fig. 2. Another good point is to wet the points of the knife occasionally, as it cuts more easily when the blade is wet.

When a number of belts have to be cut, drive two nails in a large block of wood, and against these set the edge of the belt and the edge of the square, as shown in illustration Fig. 3. This prevents either the belt or the square slipping. Some tack a slip of leather or a piece of old belt on the end of the block to protect the point of the knife as it comes through the belt.

Wide belts are more difficult to square correctly, and the difficulty often is increased by slight variations in width, which throws the square out. To avoid this and assure perfect results, the following method has proven the best:

At any point near where the belt is to be cut, measure across and find the center as at *A-A*, Fig. 4. At any distance back of this, 2 or 3 feet, find the center again, as at *B-B*. Between these two center points draw a clean, sharp line. This marks the center axis of the belt.

Now, as in illustration Fig. 5, using the square against the center line, trim off the end of the belt, holding the square firmly in position while the line is cut all the way through. Two small nails driven in on the center will keep the square from slipping. Before cutting the other end of the belt, find the center line in the manner previously described. At any point on this line other than where the belt clamps will come, take a point *C*, as in Fig. 5. Then using the square as illustrated, draw a line, *D-C-E* at right angles to the axis, and all the way across from edge to edge. It is sometimes easier to draw this line by making the points *D* and *E*, and then placing a straightedge through the points *D-C-E* to draw the line, Fig 6. Be sure the straightedge is straight, not warped. The line *D-C-E* will constitute a *base line* to measure from after the belt is in the clamps. Do not cut on this line.

The exact point to cut may be determined after the clamps have been put on and the belt brought into position. Then measure forward from the line *D-E* an equal distance on each side of the belt to the cutting point. Calipers may be used to measure over the belt clamp or ruler may be run through the edges of the clamp. As a matter of convenience,

always cut one end of the belt square and get it ready for making the joint before putting the belt into the clamp.

Remember, it is much easier to do it right than to do it over. This applies to making the completed joint as well as to cutting the belt. Therefore, it is best when joining a belt, to do so in a way which is permanent and which insures the belt's most satisfactory service.

Personally, the writer, who has had considerable experience in working with belting manufacturers in solving the difficult problems of efficient belt joining, is much opposed to methods which punch holes in the belt or which in any way cut or weaken the lengthwise, power-carrying fibers of the belt. No belt can give better service than its method of joining will permit, and if wasteful or destructive means are employed, the strength of the belt is lessened, its service impaired and its life much shortened. It is no uncommon thing to see in journeys through manufacturing plants belts in which from 40 per cent to frequently more than 70 per cent of the cross section of the belt is removed in punched holes. Many manufacturers are today running belts much heavier and more expensive than their requirements, to get strength at the joint.

The ideal belt joint is one which would run the same as endless without the drawbacks of difficulty in making and later shortening to take up stretch. Belting manufacturers themselves estimate that only a small percentage of belts need to be made actually endless. Their estimates range from ½ of 1 per cent to 2 per cent as endless requirements.

It is possible to make belt joints which run the same as endless and which meet all requirements of this 98 to 99½ per cent of the belting field, without having any of the objections noted.

The following items showing the qualifications of the perfect belt joint may be used by any engineer to check up the comparative efficiency of his methods.

The 100 per cent efficient belt joint will maintain maximum strength of belt. It will avoid destruction or weakening of the lengthwise, power-carrying belt fibers. It should prevent breaking the belt back of the joint. It must not hammer on the pulleys. It must not be subject to wear or to crystallization. It hugs the pulleys tightly and insures full transmission of power. It runs silently the same as an endless belt. It can be taken apart easily for removing or shortening the belt. It is safe against accidents or breakdowns. It will last for the life of the belt.

Pattern Draft Is An Over Worked Term

BY M. E. DUGGAN

CERTAIN remarks which I overheard the foreman patternmaker address to an apprentice because he had not given the sides of a pattern the proper draft allowance, reminded me forcibly of my own apprenticeship days when all I heard was *draft*. The hundred and one other things in connection with the making of a pattern so that it would mold properly, were seldom mentioned. It is no wonder that before I was through serving my time, I was firmly convinced that the only important factor in pattern construction was the draft. However, as I grew older, I learned to revise that opinion considerably.

Allowing a certain amount of draft on patterns is good and practical pattern-making practice; but like everything else, discretion must be exercised in its application. For instance, in plain simple patterns from which only one or two castings are to be made, it simply is a waste of time to fuss around until the exact theoretical draft is consummated. Every day I see evidence of this waste of time among young patternmakers. They pass the plane over the edge of the board, put the try-square on it, hold the board up in such a way that the light will shine through under the blade of the square, in their effort to determine when it has the *exact* degree of tape, or draft.

I derive a great deal of useful information from reading in the various trade publications what the other fellow is doing, and it is with a desire to exchange information that I present this subject to the readers of THE FOUNDRY. The pattern shown in the accompanying il-

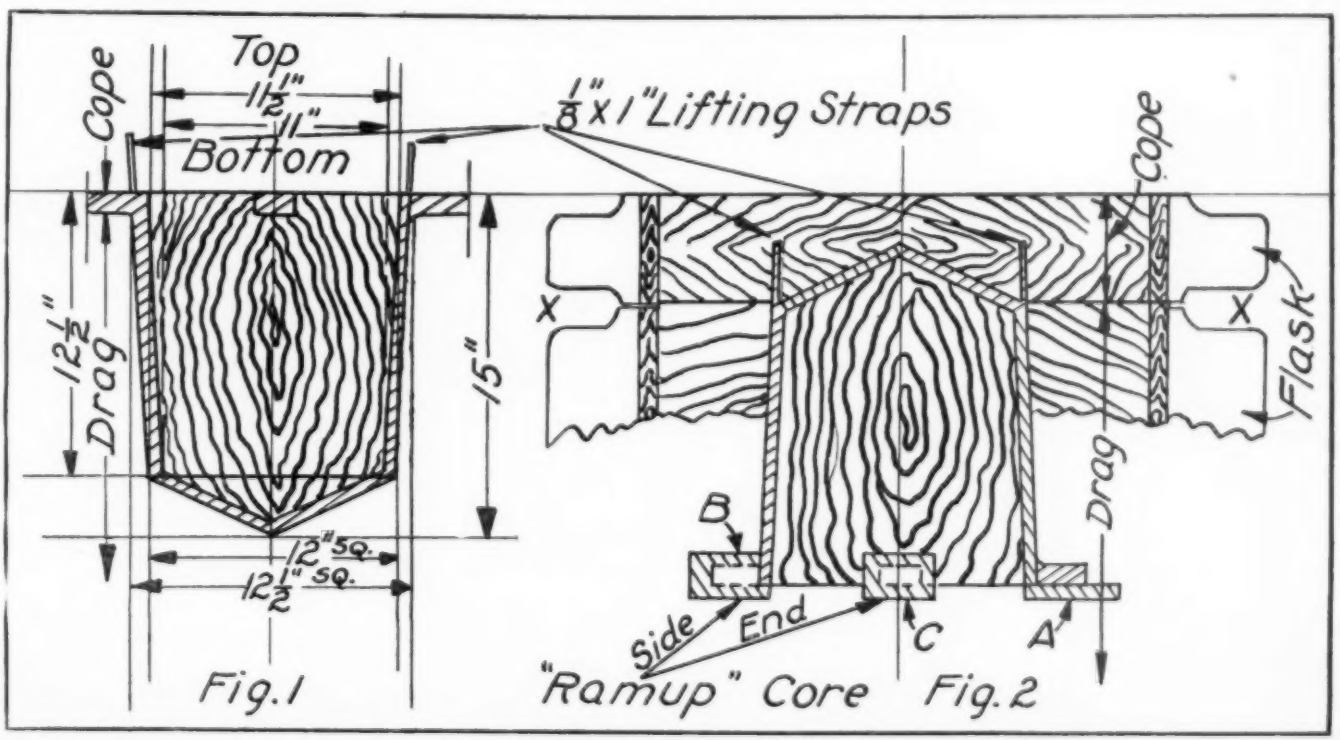


FIG. 1—THE WAY THE PATTERN WAS MADE TO MOLD FIG. 2—THE WAY IT WAS MOLDED

lustration is a fair example of what a young patternmaker whose knowledge of foundry practice is limited, can make, call it a pattern and get away with it. I will describe what was done to this pattern after it reached the foundry, and I hope to show the young journeyman who has been pestered almost to the point of quitting the trade, that a great deal of this draft stuff is simply *bunk*.

The pattern was for a cast iron hopper 12 inches square and 12 inches deep plus the 3-inch bevel bottom, ½-inch metal throughout and provided with four clamping lugs, at the top, or open end. The pattern was made under the supposition that it would be molded in the position shown in Fig. 1, that is that the inside would be coped out. The patternmaker was under the impression that on account of the lugs it could not be molded any other way. To insure an easy lift the pattern was made with a decided taper, ½-inch to 12 inches and it also was fitted with lifting straps.

When the pattern reached the foundry the molder removed the lifting straps and replaced them the other way up as shown in Fig. 2. The four lugs also were knocked off and laid to one side until the molding process had reached a certain point. The closed end of the pattern was set on the roll-over board, a number of wedges being employed under each side to keep it upright. A false frame 3 inches high was placed between the bottom edge of the drag and the roll-over board. The object of course being to bring the parting line flush with the upper edge of the drag when rolled over. Sand was then filled in and the drag rammed up nearly to the top of the pattern. The four lugs were then tucked into place and a small parting slicked around each of them; after which the lugs were removed and the cavities covered with pieces of stock slab cores. The drag was filled to the top with sand, rammed and rolled over.

After making a parting as indicated in Fig. 2 the cope was set on, rammed and lifted off and then by dint of some hard rapping the pattern was drawn out of the drag, the mold finished and closed. I should not be surprised if the foregoing statement is received with a certain amount of doubt. I know I should have doubted it at one time myself; but I have seen the castings,—such as they are, rough and heavy; but as good as could be expected under the circumstances.

How would *you* make this pattern and how would you have it molded if the drawing called for a casting with a metal thickness of ½-inch?

Personally I should ignore the drawing and make the straight part of the pattern out of four pieces ⅞-inch thick at the cope end and 7/16-inch thick at the bottom. The four lugs I should make in box cores as shown at *B* and *C* Fig. 2, and for this purpose it would be necessary to make a corebox. These cores are more satisfactory than drawing the lugs out of the sand and covering the openings with pieces of slab cores. The mold would be made in a 2-part flask as already described.

Purchasing Agents Adopt Invoice Form

AFTER two years of intensive work, in touch with 275 associations and 125 trade papers, the standardization committee of the National Association of Purchasing Agents, has recommended the adoption of the invoice form shown in the accompanying illustration. The difficulties due to lack of standardization in invoice forms, have resulted in the adoption by hundreds of concerns of their own standard forms. People from whom they buy must use these forms when billing the goods. This always has caused a great deal of unnecessary work in the billing department, because it is necessary to keep track of all these special forms from the time the order is received until the invoice goes out. A carbon copy of the invoice must be made for the records in case of a dispute; but to enter the sale on their own records, it is necessary to write the invoice all over again on the form of the vendor.

NATIONAL ASSOCIATION OF PURCHASING AGENTS
Standardized invoice adopted at 1920 Convention
19 PARK PLACE, NEW YORK

Shipper's Order No.
Date shipped
Shipped from
Shipped to
Destination

Invoice date
Invoice No.
F O B

Buyer's Order No.
Requisition No.
Contract No
Car No. and Ini.
Via

This column reserved for use of buyer
P. A. Record No.
CHECKED: With order; F O B point; Price; Calculations; Freight; Frt. chgd. back
INVOICE: Rec'd by P. A.; Sent by P. A.; To outer off; From outer off.

Terms: To be printed here

NAME AND ADDRESS OF PURCHASER TO WHOM INVOICE IS TO BE MAILED MAY BE PUT IN THIS SPACE

Charge Account Approved Approved

Four top lines are to be replaced by shipper's name and address.

Sheets to be 8½ inches wide and not less than 7 inches nor more than 14 inches long. Printed either way of the sheet. A tolerance of ⅛-inch in either dimension. Invoices longer than 7 inches have dots or short rules 7 inches from top to indicate point of fold for filing.

It is urged that all invoices be cut from 17x22 or 17x28 stock.

Certain blank spaces such as "Shipped to," "Destination," "Invoice No.," "Contract No.," "Car No.," etc., are intended for use when such information is required to identify a shipment.

Material described above received in good order _____ (Signed) _____ (Title) _____
DATE

The National Association of Purchasing Agents has appointed a committee to promote the use of this standard form along with others adopted or concurred in by the association; standardized catalog; standard shafting sizes; decimal system of pricing, etc.

The decided factor which influenced the selection of the size for the standard invoice form was the fact that the American Banker's association had some years ago, adopted a standard size for checks 3½ x 8½ inches. The check has been adopted by over 100,000 business houses and has resulted in a standard voucher 8½ x 7 inches. So many concerns file copies of invoices and vouchers together that it was considered advisable to make them the same size.

To accommodate invoices of larger size it was decided to have one dimension remain 8½ inches in all cases; but that the other might vary between 7 and 14 inches. In that way anything over 7 inches can be folded back on the 7-inch line, thus providing a sheet 8½ x 7 inches for filing purposes.

Where invoices are longer than 7 inches it is recommended that dots or short rules be placed on the sides down from the top to indicate to the filing clerk the proper point for folding. It also is urged that all invoice forms be cut from 17 x 22 or 17 x 28-inch stock.

Shop Specializes in Annealing Pots

Building and Equipment Devoted to One Definite Purpose Makes It Possible To Manufacture on a Production Basis Castings Usually Regarded as a Side Line

THAT malleable iron castings require to be heat treated or annealed immediately after they are cast before they are of any commercial value or before they can be placed in service makes it necessary to provide containers to hold them so that they may be handled while undergoing this treatment. Extensive experimenting has determined the shape and size of container best suited for this purpose and while the types vary in different plants, the almost universal practice at present favors rectangular pots approximately 30 inches long by 20 inches wide and 18 inches deep.

Owing to the extremes of temperature to which these pots are subjected during their life time it has been found advisable to design them with generously rounded corners so that while they may be described as rectangular a more accurate definition would be to say that they are oval with straight sides and ends. In addition to the factor of safety provided by the rounded corners, a narrow flange around the top edge gives greater strength. In ordinary practice, a row of pots is placed upon suitable cars and loaded with castings. The interstices between the castings are filled with mill scale or other substance of a like nature Other pots are placed on top and filled in like manner, until the tiers are three or four pots high depending upon the height of the annealing oven roof. The entire load then is pushed into the oven and the door sealed. The temperature gradually is raised from about 800 degrees to 1600 degrees Fahr., and held at that level for approximately 60 hours. The heat then is reduced gradually until at the end of the sixth day when the temperature has dropped to 800 degrees Fahr., the cars are hauled out. The pots then are dumped and the castings placed in tumbling barrels and cleaned.

Experiments now under way in some of the leading malleable shops seem to indicate that it is not necessary to pack the castings with any foreign material and that they can be annealed in much less time than formerly was considered necessary. These features of malleable iron practice were discussed by H. E. Diller in the Aug. 15 issue of THE FOUNDRY when describing the plant of the Saginaw Malleable Iron Co., Saginaw, Mich.

Classifying the Work

The advantage of segregating the different classes of work and handling the mass units generally is recognzed throughout the foundry industry. That the practice has not been adopted universally is due to the great number of contributary factors necessary to the production of castings and the utter impossibility in many cases of adopting any classification. In a general way this classification is observed in many foundries where certain classes of work are confined to definite sections of the building; while in others it has been found possible to house the different classifications in separate if sometimes adjacent buildings.

The United States Malleable Iron Co., Toledo, O., operates three foundries which are not even in the same city. One is in Toledo and the others are situated about 30 miles away in the town of Wauseon. Each one is operated as a unit, but all three are operated under centralized direction. Heavy castings exclusively are made in the Toledo foundry and all the small, light work is handled in the Wauseon plants. One of the advantages of this system is that the work can be standardized to a greater degree than if miscellaneous castings were made in the one shop, and poured from the same furnace. An advantage also is reflected in the attitude of the workmen who to a great extent in the Toledo shop and altogether in Wauseon have been recruited locally. This standardization of work and methods of course is not altogether responsible, but it certainly is a factor in enabling the company to operate with a full crew in the days just passed when not only foundrymen but other employers of labor were bewailing the shortage of all classes of workmen. The castings from the Wauseon shop are shipped in the rough to Toledo where they are used to fill the annealing pots containing the large castings. This arrangement works out to the mutual advantage of both plants. The heavy castings are cleaned at a reduced cost owing to the saving of packing meterial and the small castings which are used for packing,

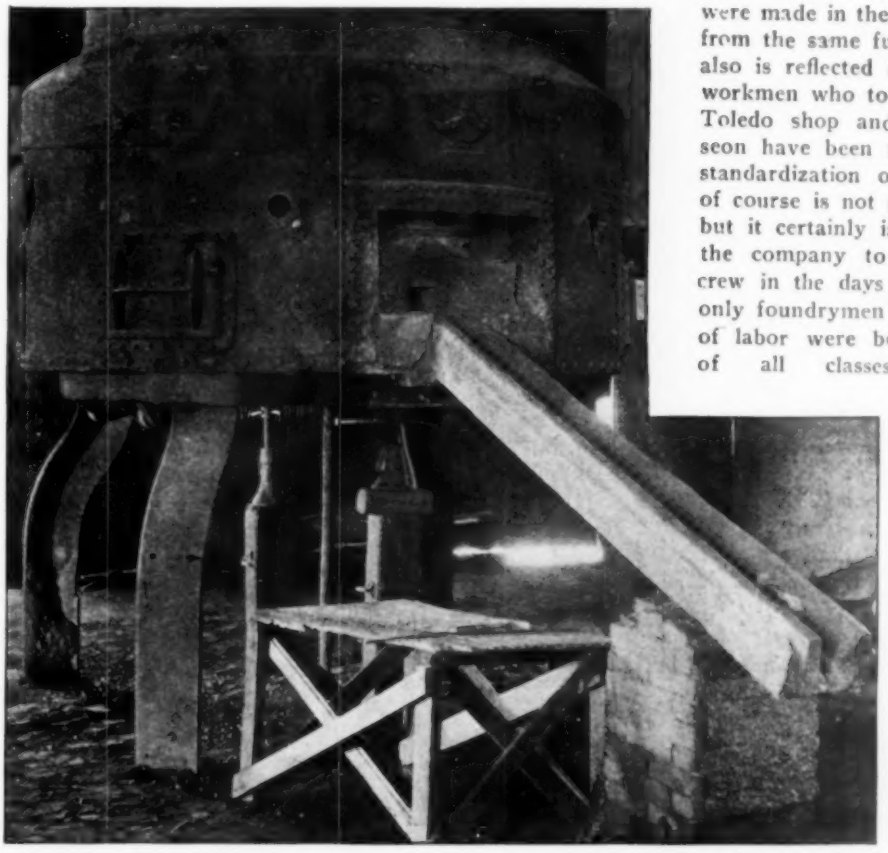


FIG. 1—THE LONG SPOUT FACILITATES FILLING THE BULL LADLES—IT ALSO ELIMINATES THE DANGER OF ACCIDENT INCIDENT TO LIFTING THE LADLES OFF A PAIR OF HORSES

FIG. 2—THE ANNEALING POTS ARE MADE IN OPEN SAND IN SPECIAL WELL VENTED CAST-IRON FLASKS

are cleaned at an exceedingly small cost. Practically all malleable shops make their own pots and pour them from the regular heat. Experiments have been tried with gray iron and steel pots, but the consensus of opinion seems to be that pots approximating the same composition as the material with which they are charged give the best service. These castings generally are much heavier than the usual run of work on the floor and are poured with the first iron which also has served to heat up the ladles.

Spruce Melted for Pots

The sprues and gates in a shop specializing on light work outweighs the amount of iron contained in the castings. The amount of this material which can be recharged in the furnace varies to a certain extent depending on other factors; but it is a constant problem to dispose of this material to the best advantage. The United States Malleable Iron Co. has solved the problem satisfactorily in its Wauseon plant by charging no sprues at all in the air furnace employed for melting the iron for its malleable castings. Instead, the sprues and gates are removed each day to an adjoining building where they are mixed with pig iron and scrap in varying proportions and melted in a cupola which furnishes iron to pour annealing pots and other hard iron castings. The shop in which the pots are made is on the same plot of land and adjacent to the malleable iron foundry and the same storage yard is common property. Shipping facilities are afforded by a spur connecting with the main line of the New York Central railroad.

The building in which the pots are made was erected about 15 years ago by a company interested in the manufacture of stoves and furnaces. The venture was not a success and the building stood idle for some time until the malleable company decided to introduce the manufacture of pots on an extensive scale. This foundry then was taken over and adapted to its new use by the installation of molding machines, traveling cranes and a new cupola and charging platform.

The building itself, as may be noted from a part of the side wall shown in Fig. 6 is solidly and substantially constructed and with the exception of the roof is practically fireproof. The walls are built of concrete blocks and the columns in the interior are also concrete. A monitor roof extending the whole length of the building and provided with pivoted sash affords ventilation and a certain amount of light.

Molding Floor Divided

The molding floor occupies the entire floor of the building, 60 x 152 feet, divided into two parts by a row of concrete columns down the center. When the building was used for its original purpose, a small cupola was located in one corner near the end. This was taken away and a large cupola erected in an addition built onto the end of the original building. This addition is about 20 feet in one dimension and the full width of the building in the other. It includes on the ground floor the cupola and ladle room and a partitioned section housing the blower for the cupola and also a blower for the heating system used in the foundry in winter. The upper floor is provided with a scale for weighing the charge and a hoisting drum for hauling the charge up to the stage from the stock yard. The charging stage also is 20 feet deep and extends the full width of the building.

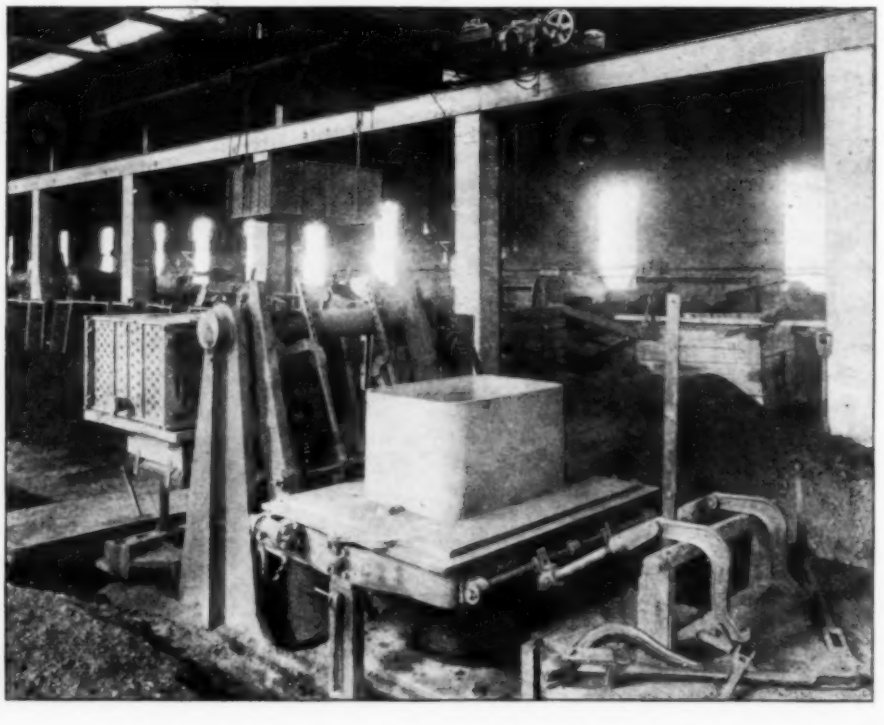


FIG. 3—THE DRAGS ARE RAMMED ON A ROLLOVER, PATTERN-DRAW, JAR-RAM MACHINE—THE FLASKS ARE HANDLED BY A 3-TON ELECTRIC TRAVELING CRANE

The cupola has an 84-inch shell but at present carries a triple brick lining which reduces the working diameter to 60 inches. It melts at the rate of about 20,000 pounds an hour and that is just about as fast as it can be handled. The charging platform is approximately 25 feet above the floor level and this feature enables the furnace crew to place the greater bulk of the daily charge in the cupola before the wind goes on. They then come down and help the men in the shop to pour off. If necessary, one man is left on the stage to finish charging. He also comes down when his duties are finished.

A platform scale in the yard, as shown in Fig. 7, and another scale on the charging floor are used for weighing the materials entering into the cupola. The straw, shown in bales in the right back ground of Fig. 5, is employed for lighting the furnace. A couple of armfuls are placed on the sand bottom and then the wood and coke are added. It is claimed that the straw gives better satisfaction than the shavings and kerosene oil usually employed for the same purpose.

FIG. 5—AN ELECTRICALLY OPERATED WINCH ON THE CHARGING FLOOR IS EMPLOYED FOR HAULING UP THE COKE AND IRON

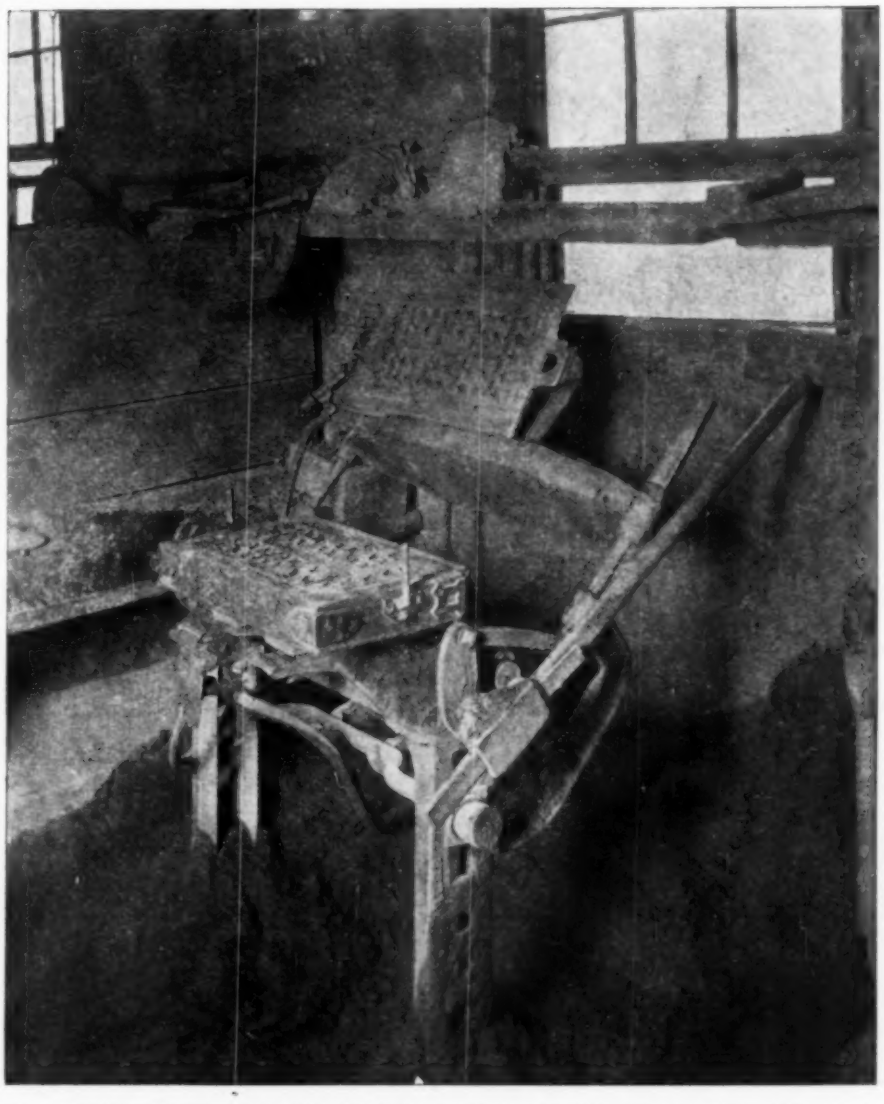


FIG. 4—SHARP POINTED STAKS FOR CLEANING CASTINGS ARE MOUNTED ON BOTH SIDES OF A PATTERN PLATE—COPE AND DRAG ARE SQUEEZED TOGETHER

The coke bed weighs 2200 pounds and on this are charged 2000 pounds of iron. Succeeding charges of coke and iron are 360 pounds and 2000 pounds respectively. The great bulk of the charge consists of gates and sprues from the malleable foundry, the percentages being made up as follows: gates and runners, 1250 pounds; steel scrap, 300 pounds, malleable scrap, 200 pounds and pig iron 250 pounds. A high phosphorus southern pig iron is used having a silicon content of approximately 2.75 per cent. The comparatively high ratio of coke to iron is due partly to the fact that white iron has little life and must be melted exceedingly hot to make it run; and partly to the fact that a great deal of the coke furnished for the foundry recently is not up to standard.

Doors Supported on Jacks

Instead of the usual two or three bars, the bottom doors of the cupola shown in the illustration Fig. 1, are supported by one bar in the center and by two jack screws resting on wooden blocks. The three supports are placed along the line of the opening between the doors and prevent them from springing either in the center or the extremities. When the heat is over the jack screws are slacked off first and removed and then the center bar is pulled from under the doors by a long hook in the hands of one of the workmen. He stands close to one of the side doors and has a chance

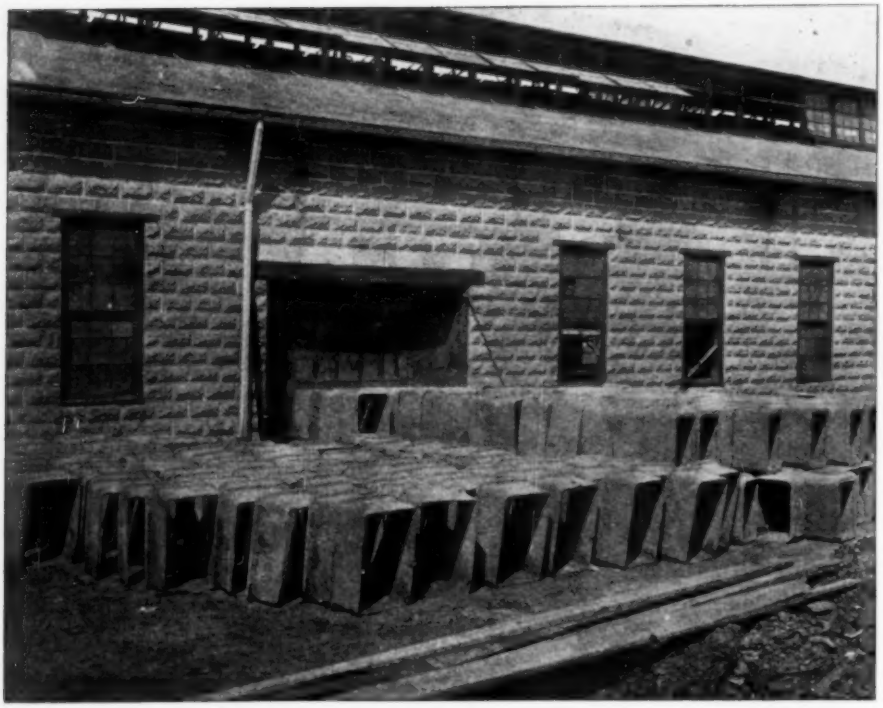


FIG. 6—THE ANNEALING POT CASTINGS ARE NOT CLEANED BUT SHIPPED BY THE CAR LOAD JUST AS THEY LEAVE THE SAND

to make his escape before the bottom drops.

After the iron has started to melt the tapping hole is not stopped until the entire charge has been drawn off and poured. Owing to the dead nature of the iron, it cannot be taken away in a large ladle and carried from mold to mold until the ladle is emptied. Each mold is poured with hot metal direct from the spout. The annealing pots vary in weight from 285 to 360 pounds and are poured with two bull ladles, one at each end. The ladles are placed under the spout in regular succession, filled and carried away. A man stands by with a hand ladle and catches over in the interval while one ladle is going out and the next one is coming in. It is claimed that the long spout on the cupola makes it easier to receive the iron in the ladles and also eliminates the danger of accidents from metal slopping over incident to lifting the ladles off a pair of stands or horses. The spout is bricked and requires little attention other than an occasional dab of clay and a daily coat of black wash. Blast for the cupola is supplied by a pressure blower made by the Wilbreham Blower Co., Philadelphia, driven by a 40-horsepower Westinghouse motor.

The heating apparatus, consisting of a number of steam coils and blower made by the Garden City Fan Co., Chicago, is located in the same room as the blower for the cupola. Steam is generated in the malleable foundry and conveyed to the neighboring building through a 4-inch main laid under ground. Air is drawn through the heated coils and discharged into the molding room through a main pipe provided with a number of small branches, an arrangement which tends to create an even distribution of heat all through the shop.

An average of 65 annealing pots are made every day on the Pridmore pattern-draw rollover, jar-ram machine shown in Fig. 3. This is placed at the opposite end of the foundry from the cupola and the molds are lifted off the machine by a 3-ton crane made by the Chisholm & Moore Mfg. Co., Cleveland. In addition to laying the finished molds down in long rows the full length of the building, the crane is employed to place empty flasks on the molding machine. At night it is used for lifting the flasks and castings out of the way for the sand cutters to prepare the sand for the following day.

Most of these castings are poured open sand and therefore the drags alone are made on the machine. When an order is received for castings which require a cope, the drags are made on the machine and the copes are rammed by hand on a plain flat board prepared for that purpose. Occasionally, when it happens that either the molding machine or the crane is temporarily out of commission, production is not stopped. The pots are then molded by hand, a separate pattern being provided for that purpose. Two men commence at one end of the sand heap made up to such a height that each flask takes just enough sand to clear a space for the next one. No bottom boards are used when the flasks are rammed by hand. They are left standing on end close to the sand pile after they are shaken out at night and therefore, it only is necessary for the molders to tip them over into position as they go along No attempt is made to level them perfectly They are left lying just as they fall; but the pattern, which is bedded in, is leveled before it is rammed up Before drawing the pattern a board conforming colsely to the inside shape of the pattern is placed on top of the sand. This acts as a stripping plate and guide and prevents the edge of the core from tearing.

The company anneals its own malleable iron castings without packing.

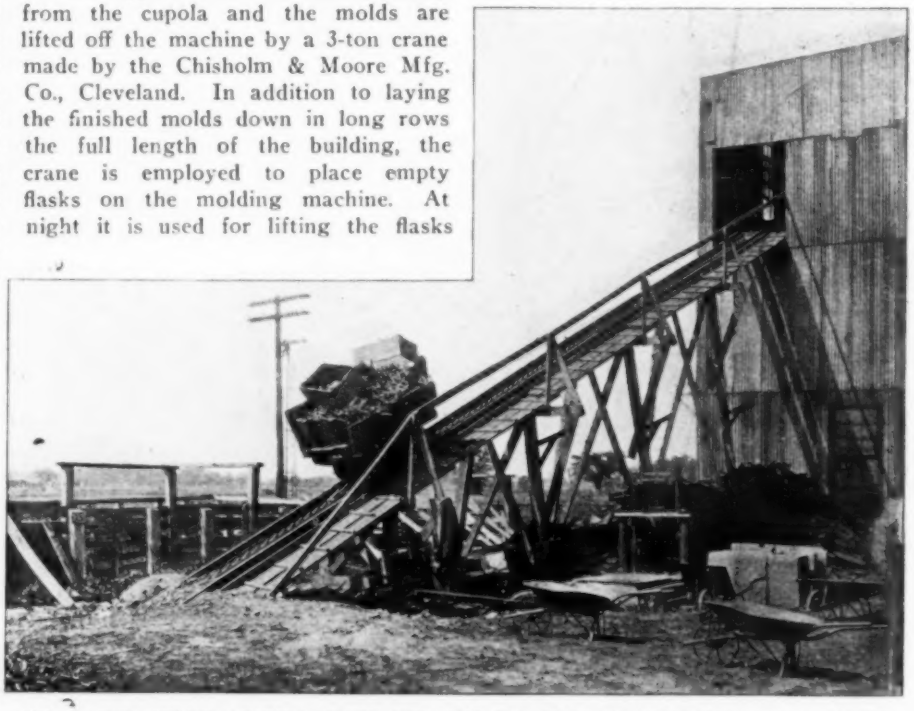


FIG. 7—THE INCLINE LEADING UP TO THE CHARGING FLOOR IS PROVIDED WITH A SAFETY RATCHET TO PREVENT THE CAR FROM RUNNING AWAY IF ANYTHING SHOULD GO WRONG WITH THE HOISTING GEAR

Plates the size and shape of the pots are placed between them, the covering plate of one pot acting as the bottom of the pot following. It is claimed that this practice in annealing is finding favor among malleable men and the demand for plates is growing steadily. At present the plates are molded by hand in shallow wooden flasks and poured of the same mixture as the pots.

Several floors of sharp pointed stars for cleaning castings are put up here every day. The patterns are mounted on a match plate and both cope and drag are squeezed at one operation of a hand power squeezing machine. The molders are made in a snap flask. The drag is placed on the match plate first, filled with sand, peined around the edge with a shovel handle, scraped off, a bottom board set and the whole turned over. The cope is handled in the same manner until the time comes to set the board. The squeezer head of the machine is brought down at this point and since the bottom board fits up inside the drag, the squeezing operation is applied to each part of the mold. The runner is punched with a sprue cutter after which the cope is lifted off, the pattern plate removed, the mold closed and carried out to the floor where it is to be poured. The snap flask is then removed and the performance repeated.

Rolls Are Poured from Air Furnace Iron

BY F. HOLBERRY

AN ADDRESS illustrated by a number of slides on the subject of "Making Castings for Rolling Mill Construction" was delivered by F. Holberry at the opening session of the Birmingham branch of the Institution of British Foundrymen. He explained that his remarks applied only to iron rolls as he had no experience with steel rolls.

Iron rolls are divided into two general classes; those cast in sand molds and those cast in chills. Rolls cast in sand, and this term always means dry sand, are commonly called grained rolls on account of the grain of the metal being conspicuous when the roll is turned. Small, plain rolls from 8 to 14 inches in diameter are rammed from a full pattern with necks and wabblers. The larger rolls are swept up in large boxes with sweeps cut out to conform to the desired shape. After the half molds are dried they are put together, using the joint for a guide, stopped in well, clamped together, then up-ended and lowered into a casting pit.

The casting pits are so arranged that the metal can be tapped directly from the furnace into the mold in the case of all large grain rolls. The metal is melted in air furnaces for nearly all kinds of rolls. This type of furnace permits the use of any amount of large scrap, such as parts of broken rolls, etc., it also furnishes those in authority an opportunity to take a trial test, cool and break it before actually tapping the furnace. The tests of course simply are taken to determine the depth of chill.

Chilled rolls are so called because they are cast in iron molds which produces a definite depth of chill on the face of the barrel. They are made in varying sizes from 8 inches diameter and 8 inches long up to 43 inches in diameter and 10 feet long. The body or barrel of the mold for these castings is made up of one or more sections of chill; but the necks and wabblers are made in dry sand molds as in the case of rolls which are cast altogether in sand.

Special Gates

Roll molds always are poured with a spinning gate attached to the bottom neck so that whatever dirt may accumulate during the pouring process will be kept in the center of the rising column of metal and be carried up into the riser or feeding head. Provision is made by means of a small pocket on the smaller sized chills for carrying the upright runner to the ingate. In the larger sizes where several sections of chill are employed to make the desired length, this is not advisable. In such cases the runner is made up in small sectional boxes about 30 inches long. The lower flange of the first runner box is attached by suitable clamps to the section of the roll flask containing the bottom neck and additional sections are built up until it comes flush with the top of the mold. A flaring casting head or basin also made in dry sand is attached to the top of the runner box. This flaring style of basin permits the iron to be poured very quickly, in fact, instances are on record of pouring a 26-ton chilled roll in 58 seconds from the time the plug was withdrawn from the pouring basin. Roll makers agree that speed of pouring exercises a decided influence on the character of the casting.

The casting temperature plays an important part in the manufacture of chilled rolls. If the temperature of the iron is too low it is liable to produce a series of pin holes near the top of the roll, a fatal defect in chilled rolls. If the chills are in good condition and free from cracks it is always safe to cast at a fairly high temperature. The life of the chills is not indefinite, and they may sometimes be prolonged by reboring. However, it is a good plan to keep a number of new chills of standard sizes available. The principal trouble experienced with roll chills is their liability to crack, sometimes vertically and sometimes horizontally around the barrel.

The author stated that roll standards or housings are made by skilled labor in another department. These castings vary in weight from ½-ton up to 30 tons. He related how he managed to pour a 32-ton casting in a shop where the largest ladle held only about 26 tons and the melting capacity of the two air furnaces was 31 tons. The problem was solved by taking five tons of metal from a cupola and pouring it into a 15-ton reservoir prepared for the purpose. The reservoir was filled by tapping 10 tons of iron from the smaller air furnace. When the large furnace had been tapped into the 26-ton ladle the plug was pulled from the runner and the cast was quite satisfactory.

Wheels and pinions are machine molded, a practice which assures an accuracy of pitch and general uniformity which cannot be obtained either when the casting is made from a full pattern or when it is made from a set of cores. Many driving pinions are made of steel which enables them to withstand very severe shocks. This is particularly true of blooming mills and in general of all two-high reversing mills. Gear wheels made on a machine can be molded with a minimum of clearance thereby reducing the shock on the pinions when the mill is reversed.

The Metal & Thermit Corp., New York, has opened a branch office at 141 Milk street, Boston. Robert L. Browne is New England manager.

The Air Reduction Sales Co., New York, recently has completed the construction of a four-story addition to its apparatus plant in Jersey City, N. J.

Analyze Loss in Aluminum Shops-II

Effect on the Casting Losses of the Stock Used in the Melting Charge as Well as of the Pouring Temperature and Melting Practice, Including the Type of Furnace Used, Is Given

BY ROBERT J. ANDERSON

THE production of any casting starts in the drafting room, and unfortunately a great many defective castings are made on the drawing board. Design is a factor over which the founder has little, if any, control, but many losses can be prevented if the foundry foreman, molder, and coremaker are called in when the question of design arises. Perkins* has outlined five essentials to insure low casting losses in founding, namely; a design from which good castings can be made continuously; the combined ideas of all interested in the making of the casting, so as to obtain the best equipment for its production; a substantial incentive offered for good work; having made a good casting to insure its shipment in as good condition as when it first left the foundry; and a clean, well-equipped shop. In making a detailed analysis of the casting losses in any foundry, it is necessary to carefully consider the factors affecting these losses.

The factors which affect the percentage of castings rejected for whatever reasons may be divided for convenience into four main classes; metallurgical factors; molding factors; miscellaneous factors, and the human element. Under these various classes, some factors fall automatically. A classification of the variable factors which alone or combined affect casting losses in aluminum founding follows, and these factors are discussed in some detail later.

A. Metallurgical Factors.
   1. Kind and quality of the melting charge.
      (a) Chemical composition of the alloy.
      (b) Quality of the aluminum ingot.
      (c) Amount and kind of scrap charged.
      (d) Method of introducing the additive elements, for example, copper.
   2. Melting practice.
      (a) Kind of furnace and furnace atmosphere.
      (b) Time and temperature of melting.
      (c) Composition of the containing vessel.
      (d) Kind and quality of the fuel used.
      (e) Use of fluxes.
   3. Pyrometry.
      (a) Melting temperatures.
      (b) Pouring temperatures.
   4. Metallurgical specifications.

B. Molding Factors.
   1. Molds and methods of molding.
      (a) Kind and character of the molding sand.
      (b) Power machine, hand machine, floor, and bench molding.
      (c) Patterns.
      (d) Flasks and boxes.
      (e) Kind of molds made for different castings.
      (f) Methods of gating, position and number of risers and venting.
      (g) Handling and placing molds.
   2. Cores and core setting.
      (a) Green-sand and dry-sand cores.
      (b) Core making.
      (c) Handling cores in the foundry.
      (d) Core setting and coreing-up.
   3. Inspection of molds before closing.

C. Miscellaneous Factors.
   1. Pouring practice.
   2. Shaking out.
   3. Handling and trucking castings.
   4. Grinding, chipping, and cleaning.
   5. Welding and repairing.
   6. Inspection of castings.

D. Human Element and Labor.
   1. Quality of the labor.
   2. Labor turnover.
   3. Piece-work and day-rate wages.

As indicated in the forgoing classification of factors which have a bearing on defective castings, certain ones fall under metallurgy. In the majority of castings, the amount of metallurgical control required is neither excessive nor complicated, but what there is should be carried out faithfully if the best results are to be obtained.

* * *

Melting Charge

THE kind and quality of the melting charge has an important bearing on the casting losses incurred in the production of aluminum-alloy castings. This follows because different alloys behave differently in casting practice, and also as the quality of the aluminum ingot and the scrap as well as the relative amounts of these materials influence the quality of the castings. Aluminum-zinc alloys are much more hot short than aluminum-copper alloys, and cracks are more predominant in the former alloys. The tendency in recent years has been toward the elimination of aluminum-zinc, and aluminum-copper-zinc alloys for castings, and most of the castings made today are of an alloy known as No. 12 alloy, approximately 92 per cent aluminum and 8 per cent copper. All the light aluminum alloys are hot short at elevated temperatures, but the 92:8 alloy is not nearly so tender as the aluminum-zinc and aluminum-copper-zinc alloys. The alloy will also effect the shrinkage to some extent, and the molding, gating, and risers will have to be varied to obtain the best results with different alloys. Foundrymen disagree regarding the effect of the quality of the aluminum ingot upon casting losses and defective castings. Many foundrymen feel that defective castings can be traced, at times, to the ingot, but the evidence is not entirely satisfactory. It has been the writer's experience that both blowholes and cracks, in isolated cases, were apparently directly due to the aluminum ingot used. There appears to be little doubt but that the presence or absence of certain undetermined constituents in the original ingot have some bearing on cracks, blowholes, and other defects in the resultant castings, but this matter has not yet been settled.*

The effect of remelting is linked with the kind and amount of scrap used in charges. Instances have occurred where castings running cracked from an all-ingot charge were relieved of this defect on the third remelting. Moreover, some foundrymen insist that they obtain better castings and have lower scrap losses when using 25-50 per cent scrap than when running on all-ingot or all-scrap charges. In fact, remelting is considered so important by one foundryman that when lacking sufficient scrap he makes up heats of No. 12 alloy from virgin ingot and 50:50 copper-aluminum and runs the melt into pigs, the pigs being used afterwards instead of scrap or remelted No. 12 alloy.

Composition Varies

The stock entering into the make-up of No. 12 alloy heats for castings may include several of a number of materials; virgin aluminum ingot; secondary aluminum ingot, run down from sheet clipping and punchings, and reclaimed from aluminum drosses; primary No. 12 ingot, made from virgin aluminum ingot plus sufficient 50:50 copper-aluminum or other material for introducing the copper; secondary No. 12 ingot, run down from borings, turnings, or defective castings and doped or not with copper, gates, spruces, and risers, and defective No. 12 alloy castings; a rich alloy, such as 50:50 copper-aluminum; and copper. The variations in chemical composition which are possible in this variety of melting materials may be readily surmised, and some founders

*Perkins, J. M., Defective castings—how to handle them. THE FOUNDRY, vol. 38, 1911, pp. 276-277; and transactions of American Foundrymen's association, vol. 20, 1912, pp. 355-361.

*Anderson, R. J., Metallography of aluminum ingot, *Chem. and Met. Eng.*, vol. 21, 1919, pp. 229-234.

will not use secondary aluminum or secondary No. 12 ingot unless they are familiar with the source and make the purchases according to chemical specifications. Unfortunately, the present methods of analysis do not furnish accurate information in regard to the casting quality of the ingot.

Just as scrap steel is the backbone of present open-hearth steel practice, so also a certain amount of scrap seems to be necessary in aluminum foundry practice. During 1919, the secondary metal market was flooded with a new class of scrap in large amounts, namely, so-called aeroplane scrap. This scrap should be of good quality, consisting of scrapped No. 12 alloy castings in the form of crankcases, oil pans, and camshaft housings for aircraft motors, and pistons and manifolds made of an alloy composed of approximately 90 per cent aluminum and 8 per cent copper. These castings were poured under government specifications calling for the use of virgin aluminum ingot of 99 per cent grade, plus hardener, plus scrap originating in the manufacturer's own plant. No outside scrap was allowed on these castings. Some foundries ran for several months in 1919 on exclusive aeroplane-scrap charges. One foundry reported excellent results, and the foundry foreman prefers this scrap, for melting charges, to aluminum or No. 12 alloy ingot. Another foundry in 1919 had difficulty in using piston and manifold scrap in its heats, the castings cracking badly in the molds. This may have been because the copper content was higher than normal, not sufficient aluminum being added to dilute the alloy to 8 per cent copper together with the fact that the melting was carried out in iron pots.

Scrap Deteriorates

After several remeltings scrap becomes poorer and poorer in quality because of the introduction of impurities, and it is held by some founders that if the scrap in circulation in the foundry is not diluted with some virgin metal difficulties are liable to occur on casting. The available evidence on this point is contradictory. In melting charges, the permissable amounts of scrap vary with the castings to be made, the specifications, and the practice at individual foundries. The specifications of the bureau of aircraft production, for example, stated that no scrap should be used other than that originating in the manufacturer's own plant in the production of Liberty motor castings. Such a specification is of some value in controlling the make-up of heats, but it cannot be relied upon to insure either uniformity of chemical composition or good castings. However, there is no doubt but that the kind and quality of the melting charge influences the subsequent scrap losses in casting production.

* * *

Melting Practice

MELTING practice for aluminum alloys is not standardized, and foundrymen and metallurgists are in doubt as to what type of furnace is the most suitable. At the present time, aluminum alloys for casting are melted in open-flame tilting furnaces, as exemplified by the Schwartz type; in tilting crucible furnaces, in clay crucibles, in natural-draft pit furnaces, in stationary and tilting iron pots; in the reverberatory type, open-flame and muffle furnaces; and in electric furnaces. Natural and artificial gas, oil, coal and coke, and occasionally producer gas, are used for fuel. The tendency in late years has been toward the use of stationary and tilting iron pots, while lately considerable interest has been manifested in electric melting. Open-flame melting has been generally condemned because oxidation is liable to be more severe than in the other types of furnaces, but it is still used in a number of foundres. On theoretical grounds, open-flame melting should not be satisfactory, but the fact remains that some founders employ this type of furnace and prefer it to others for melting aluminum alloys. Iron pots are used in many foundries, and crucibles are employed to a minor extent. The question of the effect of furnace atmospheres on the quality of castings is one concerning which little information is available. However, the importance of the effect of gas absorption is recognized. In oxidizing atmospheres, at temperatures above the melting points of the alloys, dross losses are likely to be high, and this is particularly true in open-flame melting, where the flames are in contact with the metal. The effect of reducing gases, for example hydrogen, on aluminum is not known with certainty, and it is doubtful whether reducing or oxidizing atmospheres exert more deleterious effects on the resultant castings. Oxidizing atmospheres will cause the formation of varying amounts of aluminum oxide which may become occluded in the alloy and cause unsoundness.

Both the time and temperature of melting affect the quality of aluminum-alloy castings. ** In experiments carried out on heats of No. 12 alloy at the bureau of mines, it has been found that blowholes, porosity, and general unsoundness vary with the time and temperature of melting and the pouring temperatures. Castings poured from melts which have been heated either for too long a time or at too high a temperature, or both, are prone to be more unsound than when poured from heats melted for short times and at the correct temperature. Some additional points on the effect of these factors are considered later under the head of pyrometry.

The composition of the containing vessel used for melting appears to influence scrap losses, particularly those due to cracks, and, to a limited extent, causes the failure of alloys to meet the chemical and physical specification where there are any. In iron-pot melting, the gradual dissolution of iron from the pot, taken up by the alloy, confers additional strength upon the metal at no loss of ductility up to about 1.50 per cent iron. Additional iron causes brittleness in No. 12 alloy, and when the iron is high and the copper amounts to between 9 and 11 per cent, cracks are likely to be more pronounced in sand castings, other things being the same, than when the normal No. 12 alloy is cast. Iron-pot melting may be the cause of so-called hard spots in castings if the pots are not carefully scraped to remove th complex iron-aluminum alloy (scale which forms on the sides of the po. However, hard spots due to foreign material charged into the furnaces, whether iron pots or other furnaces, should not be confused with those which are caused by mechanically entangled scale. *** Silica is reduced from plumbago-clay crucibles and refractory fireclay bricks at normal melting temperatures, and this raises the silicon content of the alloy. Although specifications calling for 1.70 per cent maximum impurities in No. 12 alloy are sufficiently liberal for foundry practice, rejections may follow on failure to meet the chemical specifications because of high iron or silicon. The method of introducing additive elements to aluminum may also affect casting losses. Where the daily output of castings is large, say 25,000 to 50,000 pounds, there is danger in making No. 12 alloy by the use of copper directly in that insufficient stirring will result in non-homogeneity of succes-

*Reardon, W. J., Foundry problems. *The Metal Industry*, vol. 14, 1916, pp. 155-158.

**Anderson, R. J., Blowholes, porosity, and unsoundness in aluminum-alloy castings. U. S. Bureau of Mines, Tech. Paper No. 241, 1919; and THE FOUNDRY, vol. 47, 1919, pp. 579-584.

***Anderson, R. J. and Capps, J. H., Inclusions in aluminum-alloy sand castings, THE FOUNDRY, vol. —, 1920, pp.—

sive casts from the same furnace or pot, and the castings are thus liable to run *hard* and *soft* in the foundry.

The effect of the kind and quality of the fuel used, whether oil, gas, coal or coke is connected closely with the type of furnaces and furnace atmospheres, but information in regard to these matters is lacking. *The use of fluxes and the care employed in skimming the pots influences the amount of occluded dross in the castings, and in turn has a bearing on casting losses. Dross in a casting may be discovered on the application of the gasoline test, on machining, and on polishing. It is, of course, possible to salvage some porous castings by doping with sodium silicate or bakelite.

* * *

Pyrometry

AN ADDITIONAL metalurical factor governing casting losses in the production of aluminum-alloy sand castings is pyrometry. Lack of sufficient pyrometric control may markedly raise the average percentage of rejections because of too high or too low pouring temperatures and overheated melts. Pouring temperatures may at times be in error because of lack of pyrometric calibration, as well as the neglect to use pyrometers. It is generally recognized that aluminum-alloy castings should be poured at more or less definite temperatures, and that a pouring temperature which is satisfactory for one job may be entirely too low for another job. Where rigid physical specifications are in force, as is the case with the production of aircraft motor castings, pouring temperatures must be carefully controlled, since otherwise test coupons may not meet the physical requirements.

The effect of pouring temperatures on the physical properties of aluminum-alloy castings has previously been shown by Gillett**to be highly important. In the early days of aluminum founding, the necessity for pouring at low temperatures was recognized. Owing to the lack of pyrometers suitable for foundry use it was the practice in some plants to hold a piece of aluminum in the metal in the pouring pot and observe how fast it melted. The rapidity of melting was a measure of the temperature. Numerous foundry foremen and molders still believe that the eye is a better gage of temperature than a pyrometer, and although pyrometers are installed today in most foundries, they are not used as often as they should be. It is little wonder that both melting and pouring temperatures are variable in some foundries where the pyrometer is used only occasionally and then merely to check the eye.

Pyrometers should be calibrated often, and it is advisable to have a sufficient number available so that those which have been used for some time can be calibrated without leaving the foundry with an insufficient number of pyrometers. In working out the correct pouring temperatures for aluminum-alloy castings, experience together with inspection of several castings poured at different temperatures will give a good indication of what the pouring temperatures for any particular casting should be. Pouring at too high temperature will usually follow from overheated melts, because in his haste to put the metal into the molds on rush jobs, the melter may not allow the metal to cool sufficiently, even though pyrometric measurements have shown it to be too hot.

Low Pouring Temperature Required

A number of defects in sand castings can be traced directly to pouring at too high temperature, and it is axiomatic with foundrymen that light aluminum alloys should be poured at as low a temperature as is consistent with the metal filling the mold. Too high pouring temperatures can result in blowholes, porosity, and unsoundness; blows; pin holes and sand holes; undue erosion of cores and molds; and in rough, dirty castings. In addition, and what is more important in some cases, the ultimate strength of aluminum-alloy castings falls off markedly with increasing pouring temperatures. The 92:8 aluminum-copper alloy, poured in sand, has an ultimate strength of about 20,000 pounds per square inch when cast at 650 degrees Cent., and only about 18,000 pounds per square inch when cast at 875 degrees Cent. High pouring temperatures for aluminum alloys should be guarded against, and the pyrometric control should be strictly maintained. Necessarily, some castings must be poured at higher temperatures than others, due to their design. A high casting temperature, whether for aluminum or other alloys, is undesirable because it reduces the rate of solidification, and consequently results in coarse microstructures and undesirable segregation. The pouring temperature is the only factor beside the use of chills or the variation in thickness, which can control the rate of solidification to any practical extent. For foundry purposes, a rapid rate of solidification is required, and in sand casting this can most readily be obtained by pouring at low temperatures. The effect upon the quality of the castings in general of pouring at too low temperatures is not definitely settled. However, aluminum-alloy castings rarely are poured at too low temperature. When this occurs, the usual defects found in the resultant castings are cold shuts, and these are ordinarily sufficient cause for rejection. Too low pouring temperatures may result from underheated melts, from pyrometer errors or from cooling a crucible of metal too much before pouring. Overheated melts can be traced to lack of sufficiently close pyrometric control of the charge. The tendency in some foundries has been to neglect temperature measurements of the metal in the furnace and rely upon correct pouring temperatures to remove inequalities resulting from overheating. In other foundries, frequent temperature measurements of the heats are taken but actual pouring temperatures are neglected. Apparently these tendencies depend largely upon the type of furnace used for melting. In iron-pot melting the tendency is to take the pot temperatures at intervals.

When the temperature of the metal is not taken in the furnace it is frequently measured in the pouring ladles as they pass on the way to the molds. If the temperature is too high in the pouring ladle, the metal is cooled by dropping in several cold gates or risers, and in fact this is usually done, the practice in these plants being to superheat the metal somewhat. While it is true that cooling to the correct pouring temperature will aid in removing the greater part of the undesirable effects of overheating, yet it appears that overheated melts, when poured into castings, have a tendency to develop coarser structures than those not heated too high, both being poured at the same temperature. Furthermore, aluminum alloys are liable to be altered as to composition by overheating. If melted in iron pots, iron will be dissolved more rapidly with increasing temperatures, while if melted in crucibles or in brick-lined furnaces, more silicon will be introduced into the alloy with higher temperatures. Also, the absorption of gas by the alloys increases with increasing temperatures, and the gases thus absorbed or dissolved are often held in solution or loose chemical combination until solidification commences when they are liberated, thus rendering the casting unsound. In addition to all these disadvantages, overheating of aluminum alloys is undesirable because oxidation, and consequently dross loss, is greater. Overheated melts poured at too high temperatures may give rise to excessively coarse microstructure; blowholes, porosity, and unsoundness;

*Les, F. C., Aluminum alloys for aeroplane engines, abstd. Chem. Abstr., vol. 14, 1920, p. 165; and The founding of aluminum, *The Metal Industry* (London), vol. 15, 1919, pp. 509-511.

**Gillet, H. W., Influence of pouring temperature on aluminum alloys, Eighth Internat. Cong. Appl. Chem., vol. 2, 1912, pp. 105-112.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book orm.

ALLOYS OF INTEREST TO BRASS FOUNDRYMEN

NONFERROUS ALLOYS RECENTLY DEVELOPED

Type Metal

An alloy for casting type has been recently patented by J. T. Dwyer; U. S. Patent No. 1203991. The alloy follows:

	Per Cent
Lead	88.00
Antimony	12.00
Phosphorus	0.02 added

German Aviation Alloy

The following alloy was used for the pistons of the Benz engine in Aviatik biplane, G, 130.

	Per Cent
Aluminum	80.02
Zinc	12.13
Copper	6.02
Silicon	0.31
Iron	1.42
Manganese	trace
Magnesium	trace

As the silicon and a part of the iron, also a little of the zinc, would be secured from commercial aluminum, the alloy would be made as follows:

	Per Cent
Aluminum	81.00
Copper	6.00
Zinc	12.00
Iron	1.00

Aluminum Piston Alloy

A patent issued to Rolls-Royce in Great Britain covering an aluminum alloy suitable for pistons contains approximately the following:

	Per Cent
Aluminum	92.50
Copper	5.00
Zinc	1.20
Antimony	0.80
Nickel	0.50

ALLOYS OF INTEREST TO BRASS FOUNDRYMEN

NONFERROUS ALLOYS RECENTLY DEVELOPED

Aeroplane Alloy

According to H. J. Owen, the following alloy was used by the Birmingham Aluminum Castings Co., Birmingham, England, for casting aeroplane parts.

	Per Cent
Aluminum	84.00
Electrolytic Zinc	13.25
Copper	2.75

This alloy has the following physical properties:

Tensile strength, pounds per square inch,	26,880 to 31,360
Yield point, pounds per square inch,	17,920
Elongation, in 2 inches, per cent,	6 to 7

Aluminum Solder

An alloy for soldering aluminum recently patented by C. A. Stewart; U. S. Patent No. 1222158, is composed of:

	Per Cent
Tin	69.07
Lead	28.77
Zinc	1.44
Silver	0.72

Aluminum Piston Alloys

An aluminum alloy that is claimed to be suitable for pistons for internal combustion engines has been patented by J. H. Bamberg, U. S. Patentt No. 1296592. The alloy follows:

	Per Cent
Aluminum	94.00 to 94.50
Tin	1.00 to 0.50
Copper	5.00 5.00

A second alloy patented by the same inventor for the same purpose is as follows:

	Per Cent
Aluminum	95.50
Copper	2.50
Magnesium	1.50
Tin	0.50

pinholes and sandholes; occluded dross; and other defects. Overheated melts, after cooling to the correct pouring temperature, may result in any or all of the foregoing defects, but they will not be so pronounced as when poured at too high temperature.

* * *

Metallurgical Specifications

THE effect of metallurgical and other specifications on casting losses is thoroughly recognized by foundrymen; increasing rigidity of specifications raising the number of rejected castings, as a general rule. Specifications covering chemical and physical requirements in various classes of aluminum alloys are not yet worked out satisfactorily but steps have been taken in that direction. Under some government specifications for castings made from No. 12 alloy, chemical and physical properties are specified, and castings may be rejected if these requirements are not met. Usually there is no difficulty in meeting the chemical requirements, but physical properties are not so readily met. This is so because the shape and the method of gating test bars, as well as the pouring temperatures, influence the ultimate strength. For example, some foundries experienced considerable difficulty in obtaining tensile test values as high as 18,000 pounds per square inch at the beginning of their production of Liberty motor castings, but on changing the shape and dimensions of the bar, this difficulty was overcome. However, more castings were scrapped in connection with this work because of troubles with the interpretation of salvage and inspection specifications. This matter is discussed under inspection of castings. Few castings are rejected because of low physical values of the test bars. It should be added, however, that specifications vary as to how test bars are to be cast. Under British practice several separate test bars are cast in chill molds, while in the United States the bars are cast both separately in sand molds and as a coupon with the casting.

* * *

Molding Factors

THE greater part of the casting losses occurring in the production of aluminum-alloy sand castings can be traced to factors associated with molding practice, including the methods of molding; kind of sand and cores; core setting and the inspection of molds before closing. The following estimated figures for casting losses in a large modern foundry producing a six-cylinder motor crankcase may be of interest in this connection*

Maximum percentage of castings rejected	29.0
Minimum percentage of castings rejected	3.0
Average percentage of castings rejected	9.0
Percentage of castings rejected for defects which could have been eliminated only with great difficulty	5.0
Percentage of castings rejected for defects due to carelessness, lack of supervision, etc.	4.0

The defects which could have been eliminated with great difficulty, if at all, were said to be attributable to foundry peculiarities and the human element.

* * *

Molds and Methods of Molding

TRAPHAGEN has written a most interesting paper**on scrap losses in iron and steel founding, which merits the careful attention of all foundrymen. Traphagen suggests that each foundry should employ a competent experimental molder who is engaged to study and devise the most suitable method of gating and heading each casting job which comes into the shop. When the desired method of molding has been worked out and sound satisfactory castings are the result, the job can be put into production. Similar ideas have occurred to many other foundrymen, but too often, particularly in jobbing shops, the patterns are turned over to a molder with instructions to put up so many flasks, and no detailed advice as to gating or heading. Thus, jobs are put into production before the difficulties of the work are apparent, and with many classes of castings it is impossible to determine in advance where the difficulties lie, with the result that a needless number of castings may be scrapped because of the same defects.

The gating*** of each individual job presents features peculiar to itself, and it would seem as though lack of attention to this detail is the cause of many waster castings. If the molding is worked out before the job is put into production, several corrections in methods can be made after each experimental casting is poured, and much scrap can be eliminated. When the molding has been successfully planned and the job is satisfactorily in production, a good casting can be photographed with the gates and risers attached and such notes made that in the future when a similar casting is ordered a permanent record will be available. It should not be thought that experimental molding is necessary for every job that is brought to the shop. If this were the case, an endless number of records would be necessary Few molders or foundry foremen can rely upon memory for the proper method of molding every type of casting, and therefore a permanent record showing the proper method of molding, gating, heading, position of chills, and so on would be invaluable.

Little Scientific Investigation

So far as the available literature is concerned, there appears to have been but little scientific investigation of the difficulties met with in nonferrous molding sand practice.* The nonferrous alloys and particularly the light aluminum casting alloys are run at rather low temperatures when compared with steel-casting practice. Burning-on difficulties, which have never been eliminated in steel practice, are not so frequent in aluminum founding, but the increased tendency to oxidation, greater mobility and sand-searching power of aluminum alloys present peculiar difficulties. Sand penetration by mobile metal may be prevented by using sands of fine grain and close bond, though the self-venting qualities and permeability of a mold are thus partly sacrificed. Lack of fundamental empirical data of the relation of aluminum alloys to different sands prevents any speculation as to the relation of sands to casting losses. In considering the relation of sands to casting losses, it is necessary to have, as a basis, full laboratory information regarding the sands. Data required would include chemical and mineralogical analysis; screen test, character and composition of the bond; tensile, compressive and transverse tests for the molds and cores; thermal conductivity; permeability; and porosity. Casting losses may be correlated with the above properties of the sands and with the chemical and physical properties (latent heat of fusion, specific heat, and thermal conductivity) of the alloys cast. At the present time, wet sand and improperly tempered sand—too high or too low moisture content, and improper binding composition—are direct causes for some casting losses, and aluminum founders have experienced no little difficulty with the sand question.

Alloys Hot Short

Numerous rules have been given**for the molding and casting of aluminum alloys, some of which are highly contradictory. In a general way, without taking up the details of aluminum molding practice, it may be said that in casting aluminum alloys in sand molds one is

*Private communication, June, 1919.

**Traphagen, Henry, The value of a scrap pile, paper before the American Foundrymen's association, Philadelphia September, 1919; and THE FOUNDRY, vol. —, 1919, pp. ..

***Fuller, B. D., The gating of castings, THE FOUNDRY, vol. 22, 1903, pp. 13-17.

*Roswell, P. G. H., Molding-sands for nonferrous foundry work, *Journ. Inst. of Metals*, vol. 22, No. 2, 1919 pp. 277-298.

**Aron., Casting aluminum, THE FOUNDRY, vol. 24, 1905, p. 91; anon., Recent practice in casting aluminum, *The Metal Industry*, vol. 3, 1905, p. 49; anon., Casting aluminum and aluminum alloys, ibid., pp. 239-240; anon., Aluminum crankcases made in England, THE FOUNDRY, vol. 47, 1919, pp. 781-782; anon., Practical hints on molding and casting aluminum, *The Mechanical Engineer*, vol. 29, 1911, p. 299; anon., Casting aluminum in green sand molds, abst., *Journ. Inst. of Metals*, vol. 2, No. 2, 1909, p. 311; anon., Rules for casting aluminum, *Mechanical World*, vol. 31, 1902, p. 298.

dealing with alloys of low specific gravity which are also hot short. Mold pressures, due to the head of metal on pouring * are consequently not so serious as in either iron, steel or brass. The ordinary molding sands used for brass are satisfactory, although finer sands, such as the fine Albany sands * * may be preferred for complicated castings. The sand should be worked rather dry, and the molds rammed lightly. The use of large gates and risers * * * is generally recommended, and the effect of characteristics of cores in relation to casting practice has been considerably discussed from the practical standpoint. One foundry applies shrinkage balls to all castings wherever possible and has secured good results in reducing casting losses arising from shrinkage holes and cracks. The general aspects of the use of shrinkage balls has been dscussed **** by Sperry and others.

Other molding factors which affect casting losses include the condition of molding flasks and boxes and the handling and placing of molds. Boxes kept in poor repair and unwieldy clamps may increase the number of runouts, cause cope drops, and in general be a source of irritation to molders. Rough handling of molds by hand or cranes may break the molds or loosen the sand, and consequently cause defective castings.

* * *

Cores and Core Setting

MANY of the losses in aluminum founding can be traced to cores. The question of using green-sand or dry-sand cores is ever present. The cost of making dry-sand cores is, of course, higher than that for green-sand cores and some founders hope to save this cost by using the latter as much as possible.

Castings rejected because of dirty cores, cores with paste or sand left in, and broken cores are scrapped for avoidable causes. Rough handling of cores in moving them from the core room to the drying ovens to storage and to the floor racks is mainly responsible for broken cores. Cores broken by the molder in coring up account for few losses. Defects in castings due to coring up may include setting cores wrong; leaving cores out; setting dirty, broken or pasty cores; and to core sand rubbed off on setting. These difficulties with the exception of leaving cores out which can be eliminated by mold inspection, can be largely eliminated by proper inspection of cores before they are delivered to the molder.

* * *

Inspection of Molds

ONE of the most effective methods of reducing casting losses which are due to molding factors is to increase the molding supervision; i. e., install a competent plan of mold inspection. If a thoroughly competent mold inspector examines each mold and the cores before the cope is put on and the mold closed, particularly in the case of the large castings, many of the losses due to carelessness can be eliminated.

* * *

Miscellaneous Factors

UNDER the head of miscellaneous factors which influence casting losses, there are included a number of items which cannot be conveniently discussed under either molding or metallurgy. These include pouring practice, shaking out, handling and trucking of castings in the foundry, grinding, chipping and cleaning, welding and repairing, and inspection. All of these affect the casting losses due to rejection because of certain defects in the castings. Pouring practice accounts for some losses such of those due to short pours and cold shuts. Short pours in large foundries are due in the main to not filling the pouring ladles or crucibles sufficiently full, because the requisite amount of metal to pour a casting is usually determined in advance by the foundry superintendent. In small foundries and more particularly in jobbing shops, whether large or small rejections due to short pours are largely due to miscalculations, and it is surprising that this is so general. Short pours can be practically reduced to zero by proper supervision. Cold shuts may be due to delays in pouring the metal after it leaves the furnace, and this is predominant in foundries where the melting is in advance of the molding. There should always be molds waiting for metal rather than vice versa.*

One other phase of pouring practice remains to be touched upon, namely, the speed of pouring. Fast and reckless pouring may cause the erosion of sand from molds and cores, and therefore be a direct cause of casting losses. Another of the more important of the miscellaneous factors also is connected with the breakage losses incurred in shaking out, and in the handling and trucking of hot castings in the foundry. Where the rate of production is high and the jobs are rushed, and also where floor space is at a premium, castings may be shaken out of the sand too soon. The hot shortness of aluminum alloys at temperatures not far below the melting points has been mentioned. Aluminum-zinc alloys are more subject to breakage on shaking out than aluminum-copper alloys, but for castings of either of these alloys sufficient time should elapse before shaking out. Cooling can be hastened by pouring water on the sprue heads after final solidification, and this permits shaking out sooner and also wets down the sand. However, it may set up unequal cooling strains—a disadvantage not to be overlooked.

Breakage due to handling and trucking is usually higher in large foundries under fast production and where traveling cranes are used for pulling off the copes. Few castings are broken in transportation if they are sufficiently cold, but if dropped from any height from a crane sling while hot, breakage will surely be heavy. Few castings are broken in knocking out core sand, cutting sprue, or removing gates and risers, nor are many scrapped because of band-saw or grinding errors. Scrap losses in chipping are appreciable because of the character of the work, and it is difficult to eliminate losses at this end.

Welding Losses Variable

Losses due to welding and repairing are variable but are sufficiently appreciable. The reclamation and salvage of aluminum-alloy castings by welding and soldering cannot be dealt with in this article other than for the purpose of considering the relation of welding and other repairing of defectives to scrap losses. Strictly speaking, welding should not be construed as affecting scrap losses in casting production, but the fact must not be lost sight of at this time that some castings are scrapped on welding. Thus, castings may crack on welding and it may be necessary to either reweld or scrap the casting. Aluminum-alloy castings are welded usually by the oxygen-acetylene or other gas methods, and welded castings are liable to crack on cooling. Cracking is frequent in complicated castings during welding if they are not preheated. Warping may also occur on welding and castings may become so out of alignment that this defect cannot be overcome on machining. Warping on welding after machinng cannot be prevented entirely although this may be mitigated to some extent by clamping the machined face to another piece of the same alloy.

Owing to heavy rejections because

*Lake, H. M., Functions of Sand Binders. Trans. Am. Foundrymen's Assoc., 1916, pp. 192-200.

**Lake, E. F., Aluminum castings. THE FOUNDRY, vol. 30, 1907, pp. 160-165.

***Anon., The use of aluminum for automobile castings. THE FOUNDRY, vol. 22, 1903, pp. 255-256; anon., Casting aluminum. THE FOUNDRY, vol. 14, 1899, pp. 128-129; Wooder, C. E., Aluminum and alloys. THE FOUNDRY, vol. 24, 1904, p. 194; anon., The use of aluminum in automobiles. *The Metal Industry*, vol. 1, 1903, pp. 5-6; anon., Producing casting for the automobile trade. THE FOUNDRY, vol. 41, 1913, pp. 87-92; Lea, F. C., work cited; Collins, J. W., work cited.

****Sperry, E. S., The use of shrinkage balls on patterns. *The Metal Industry*, vol. 1, 1903, pp. 127.

*Anon., The use of aluminum for automobile castings. THE FOUNDRY, vol. 22, 1903, pp. 255-256.

of warping on welding machined parts many castings cannot be welded but must be soldered or scrapped. Moreover, the chemical composition of the alloy affects the scrap losses due to cracking on welding. Aluminum-zinc alloys are more brittle at welding temperature than are the aluminum-copper alloys. At best all of the aluminum alloys, including No. 12 alloy, are somewhat brittle at the welding temperature and cracks are likely to develop,* particularly in a long weld, if the entire weld on one side is finished before starting on the other side. Welds on aluminum alloys must be made rapidly so as to avoid shrinkage cracks, but both preheating and slow cooling after welding are also highly important. In general, if no crack appears in a weld during the first few minutes after completing the weld, no cracks will appear at all. This is because of the high thermal conductivity of the alloys. The purity of the oxygen and acetylene used in oxyacetylene welding is of importance for the reason that impurities may be absorbed by the alloy at the welding temperature. Since aluminum combines with nitrogen at 800 degrees Cent., forming a nitride, the existence of nitrogen in the oxygen used would tend to render the weld brittle and unsafe. Under certain conditions nitrogen from the air also may combine with the metal. Success in the reclamation and salvage of aluminum-alloy castings by autogenous welding depends largely upon the individual skill of the welder. The character of the defect to be remedied will determine whether a casting should be preheated or not. If the defect extends into the body of the casting rather than on the edge it is advisable to preheat it.

The inspection of castings is an important step in their successful commercial production, but many foundries have neglected this work in the past. Hasty and inadequate inspection is as useless as inspection by incompetent inspectors. Thoroughly competent inspectors are not readily available, and it is advisable for foundries to train their own inspectors. The inspector should preferably be a man familiar with both machine shop practice and molding, and his decisions should be rendered with impartiality. A competent inspector will be able to determine at a glance whether a casting is worth machining. He will also be able to tell how serious any defect is and will be of assistance in reclaiming castings by demonstrating how repairs can be made. A competent inspector can also be of still greater value to the foundry if he is in a position to explain to the molder the causes for defects due to molding errors.* The cast record of a foundry cannot be reliable unless the inspector's records of casting losses are accurate, and it is important that not only should the work of inspection be competently performed but also the records should be accurately kept.

* * *

The Human Element and Labor

OTHER factors which cannot be overlooked with safety in considering aluminum-foundry casting losses include the human element and labor. It is not proposed to discuss the relation of the human element to industrial work at any length but it is advisable to point out that this factor must be recognized in analyzing faulty production. From existing production records, it has been shown how casting losses due to inequalities in molding vary with the number of green molders on the job. A molder may be skillful on iron and steel molding, or on brass and bronze work, but it may take a few days at least to get him used to aluminum molding practice. Also, aluminum molders if starting in a new shop require some few days to become acquainted with their surroundings and the character of the work. This is all reflected in the casting losses.

*Miller, S. W., Oxyacetylene welding, *The Industrial Press*, 1916, New York, p. 187.

*Bedell, F. M., Cost of defective castings, THE FOUNDRY, vol. 23, 1903, pp. 130-131.

How and Why in Brass Founding

By Charles Vickers

Starting a Small Brass Casting Shop

We are contemplating starting a small jobbing brass foundry to employ three or four molders, and the location we have in mind is a small country town where there is no power. We desire to learn the type of furnace it would be best to install, and approximately the amount of capital that will be required.

Considering the conditions one or more natural draft, coke-fired crucible furnaces would be the most satisfactory melting medium to install. The foundry will most probably be located on the ground floor, so the furnaces can be placed in a pit, with their tops about 12 inches above the floor level. The foundations of the chimney should extend below the bottom of the pit. The latter should be three feet deep; width, 5 feet, 4 inches, length 6 feet 8 inches when bricked up. The stack should be 18 x 18 inches square, and 30 feet high. This stack and pit will accommodate three furnaces taking No. 35 crucibles.

Foundries of this capacity have been started and run on a capital of $5000, but this was before the present era of high prices, and $5000 then was equal to $10,000 now, and possibly more.

Pin Holes in Nickel Bronze

We are having trouble from porosity in nickel bronze castings. The mixture consists of copper 89 per cent; nickel, 9 per cent, and 1 per cent each of tin and zinc. We thought at one time the trouble came from a small core running through the castings being small bushings, but have now come to the conclusion it is due entirely to the metal, although it is carefully melted. Accordingly we tried a small amount of aluminum to stop the pinholes, then we tried a small amount of antimony. The latter gave the best results but the holes still persisted. In making the alloy we use tubing of Benedict metal to introduce the nickel. The mixture is melted in a crucible.

The porosity exists in the metal. Suppose that castings were made of 98 per cent copper, 1 per cent tin, and 1 per cent zinc, how many could be expected to come sound? Few, unless the metal was melted in an inert atmosphere. One per cent of zinc is not sufficient to deoxidize copper and insure a commercial production of sound castings. When a portion of the copper is replaced by nickel, the problem of getting sound castings is not changed in the least for

the better; rather the reverse. If the one per cent of zinc is added as yellow brass, or better still, as an alloy of 50 per cent zinc, 50 per cent copper, much better results will be obtained from a deoxidizing point of view. In this particular case, if half a pound of manganese copper be added per hundred pounds of alloy, the castings will come free from these holes. Use the manganese copper containing 30 per cent manganese, and consider 0.5 per cent as the maximum amount to use. In place of the tubes of Benedict nickel, it would be better to add the nickel in the form of an alloy of 50 per cent nickel, 50 per cent copper.

Method of Operating Oil-Fired Brass Furnaces

We have lately experienced considerable trouble in making brass and bronze castings in open flame furnaces. The castings have no surface defects but when turned off we find hair cracks and when the castings are broken, quite a lot of oxide shows in the metal especially around the risers.

Can you suggest any book that will present the correct analysis for good fuel oil for melting brass, also the correct air pressure for burning oil in 500 to 1000-pound capacity noncrucible furnaces of the tumbling barrel type? We use from 11 to 12 ounces on the larger furnaces and from 10 to 11 ounces on the smaller, and believe there should be more pressure. We keep a careful record of the melting time, and take the temperature of every heat. We never cast brass or bronze at a temperature exceeding 2100 degrees Fahr., or under 1900 degrees Fahr. As near as we can judge we have a neutral flame, neither oxidizing or smoky. We shall be pleased to get your opinion in regard to these matters.

While books can be obtained that treat of oil fuel, it is doubtful if any figures will be found relative to correct air and oil pressures for brass melting furnaces of any type. There are no standard pressures; usually each installation will differ in that respect from other installations. Some believe in high and others in low pressure air. The air pressure used by the questioner is low pressure, and although lower pressures are in use, it is our belief it is too low for the type of furnaces and that 16 ounces air pressure should be considered a minimum, while 18 ounces would be better. This with oil pressure of around 40 pounds should prove satisfactory. In all cases there should be abundant air, also plenty of oil in reserve. It would appear the difficulty with these castings is due to too slow melting. This trouble is about as bad as burning the metal. Many melters at the start of a heat use a slightly smoky flame to warm up the metal without oxidizing it excessively on the surface. Copper, brass or bronze does not need to be molten to oxidize; oxidizes rapidly at a red heat and this stage is soon reached in an oil or gas-fired furnace. If there is plenty of air after the metal gets hot it can be quickly cut down by increasing the air, if at this stage it is necessary to decrease the oil on account of shortage of air, the melting will be prolonged and all this time the flame is playing on the solid, heated metal. Most of the oxidizing and sulphurizing of a heat is done before the metal melts, and this is the reason castings are found porous in spite of the use of charcoal and fluxes. Before the metal is melted the charcoal fails to cover it.

The starting flame need not be distinctly smoky, neither should it be a clear, white flame. Reserve this flame for the melting and do not attempt to melt until the metal is heated through, give it time first to soak up the heat, then the clear white flame will quickly reduce it to the liquid condition when it is under cover of the flux or the charcoal, or both combined. When the metal is liquid still further increase the air until the green flame shows. In this manner the metal is heated through, quickly melted and is brought to casting temperature. The furnace should be kept clean by the use of fluor spar, or other brass furnace fluxes. If the oil is high in sulphur it is important to get the metal under cover as quickly as is consistent with giving it time to get heated through. The practice of rushing the melting from the start should be condemned. With such practice the metal may be cold internally and melting externally. This cannot be otherwise than injurious and should be prevented.

The analysis of oils varies considerably; an oil from Beaumont, Texas, had the following analysis: Carbon, 84.60 per cent; hydrogen, 10.90 per cent; sulphur, 1.63 per cent; oxygen and nitrogen, 2.87 per cent; calorific power, b. t. u. per pound, 19,060. A Pennsylvania oil contained, carbon, 86.40 per cent; hydrogen, 13.90 per cent; sulphur, 0.06 per cent; calorific power, 20,200. An Ohio oil analyzed, carbon, 85 per cent; hydrogen 13.80 per cent; sulphur 0.60 per cent; oxygen and nitrogen, 0.60 per cent; calorific power, 20,060 units. A California oil analyzed; carbon, 81.52 per cent; hydrogen, 11.01 per cent; sulphur, 0.51 per cent; oxygen and nitrogen, 6.92 per cent; calorific power, 18,667 units.

The best oil for brass melting is the Pennsylvania because it contains little sulphur, but it is not likely such oil is available for melting furnaces now. In this case have an analysis of the oil, and if high in sulphur, add barium hydroxide or chloride to the flux. The proper pouring temperature will depend upon the alloy and the weight of the castings. For gun metal, 1900 degrees Fahr. would be low, the best pouring temperature being from 2100 to 2282 degrees Fahr. Either below or above this temperature the castings will be porous.

Points on Metals, Sand and Molding

Can you please answer the following questions? (1) *How can phosphor bronze be melted to avoid porosity using a tilting oil-fired furnace as melting medium?* (2) *Is an alloy of 80 per cent copper, 8 per cent tin; 8 per cent lead, and 4 per cent of ten per cent phosphor copper a good one? If not, name one.* (3) *Is 80 copper; 10 tin; 10 lead a good bearing metal. Should a flux be used therewith?* (4) *We are using a mixture of 100 pounds copper, 13 pounds aluminum to cast around iron castings. In remelting the scrap and sprues, what percent of aluminum should be added to hold the aluminum content to 11 per cent in the analysis?* (5) *We are using Sandusky sand. Is Albany considered the best sand? What grade?* (6) *Should the molds be dusted with flour?*

(1) In melting the copper for the bronze, keep it covered with some sulphur free substance like charcoal, but if the charcoal blows away, mix it with borax.

(2) This alloy is considered a good bearing metal.

(3) 80-10-10 is the standard bearing alloy for heavy pressures and hard service. It has to be fitted to the shaft as it only conforms to a comparatively limited extent.

(4) About 0.20 per cent of aluminum is considered sufficient to compensate for oxidation.

(5) The best sand is a matter of opinion. Some founders prefer one kind of sand, others another kind, otherwise, there would be sale for only one kind. The grade or degree of fineness of the sand will be governed entirely by the weight of the castings to be made. Thus for floor molding a coarser sand must be used, otherwise, the gases generated by the hot metal will not be able to find exit, and the casting will suffer.

(6) Molds for brass usually are dusted with flour. Molds for large and heavy castings are coated with plumbago. They are often made in dry sand; the plumbago being painted on. It is mixed with molasses water to form the paint. For phosphor bronze, a surface-dried mold, painted with plumbago, is the best.

Foundry Maintained on Repair Ship

The U. S. S. Prometheus Was Repair Ship for the Destroyers, Patrol Boats, Mine Sweepers and Transports Basing at Brest, France, During the War

BY LIEUT. R. F. NOURSE, U. S. NAVY

THE efficiency of a fleet or of an individual ship of the navy depends in a great measure on its ability to move when required and to keep moving for long periods of time. Next in importance to the two items of fuel and provisions comes the mechanical equipment of the ships. To keep this at the highest point requires constant watchfulness and effort. All naval vessels are equipped with facilities to make ordinary repairs, and many times accomplish surprising feats which do credit to the ingenuity of their personnel; but it is often desirable and necessary to receive outside aid and that is where the repair ship justifies its existence.

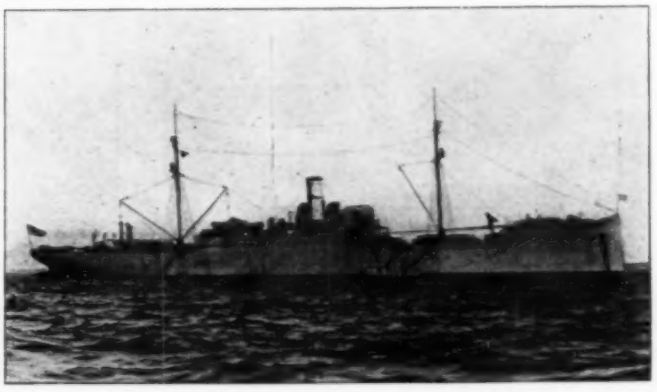


FIG. 1—U. S. S. PROMETHEUS, REPAIR SHIP OF THE ATLANTIC FLEET, 1920

This necessity is recognized by the navy department and in order to keep ships at sea for a maximum period each fleet is provided with a repair ship. Such a ship is the U. S. S. PROMETHEUS, which is of the following dimensions: Length over all, 465 feet 10 inches; extreme breadth, 60 feet 2½ inches; normal draft, 20 feet; and displacement at 20 feet draft, 9220 tons.

Since April, 1919, this vessel has been detailed with the Atlantic battleship fleet. She was stationed at Brest, France, during the war as repair ship to destroyers, patrol boats, mine sweepers and transports basing at that port. An enumeration of the various machinery and repair equipment which was installed in the various shops on this ship will give some idea of the repair facilities of the PROMETHEUS.

Metal Working Machinery

Lathes, 24
Milling machines, 4.
Vertical boring mill, 1.
Horizontal boring mill, 1.
Planers, 2.
Shapers, 3.
Grinders, 4.
Surface grinders, 1.
Turret lathes, 2.
Rolls, power, 1.
Steam hammer, 1.
Corrugating machine, 1.
Hand rolls, 2.
Hand shears, 1.
Engraving machine, 1.
Vertical drill press, 6.
Radial drill, 3.
Sensitive drills, 3.
Mandrell press, 2.
Slotting machine, 1.
Power hack saw, 2.
Shear and punching machine, 1.
Forging press (150-ton), 1.
Pipe bending machine, 1.
Cornice break, 1.
Hydraulic press, 1.
Hydraulic test pump, 1.
Electric traveling cranes, 3.

Wood Working Machines

Universal wood worker, 1.
Band saw, 1.
Joiner, 1.
Combination saw, 1.
Mortice and boring machine, 1.
Wood lathe, 2.
Saw filing and setting machine, 1
Surface planer, 1.

All of these machines are installed in the various shops on the berth and platform decks and are motor driven. On board are an arc welding outfit and an oxygen acetylene welding shop, for which there is an acetylene generator. All shops are fitted with air lines for pneumatic tools.

While all the battle ships and most of the cruisers are fitted with brass furnaces and do a large amount of small work,, the PROMETHEUS surpasses any of them in foundry equipment. The foundry is situated in the after-hold between frames 99 and 117 and extends from the main deck down, including the berth platform decks with store rooms underneath.

On the lower platform deck in a floor space of 1940 square feet six Monarch tilting furnaces are situated on each side toward the after end; two of 120 pounds capacity, two of 200 pounds capacity, and two of 300 pounds capacity. These furnaces are oil fired and are provided with hoods with gas escapes. Near the center aft are three Whitmaan cupolas, one No. 0, of ¼ to ½-ton capacity, one No 1 of ½ to 1-ton capacity and one No. 2 of 1 to 2 tons capacity. Forward of the brass furnace and cupolas, is the molding floor in the center of which is a sand

FIG. 2—THE FOUNDRY IS PROVIDED WITH THREE CUPOLAS AND SIX TILTING BRASS FURNACES

From a paper presented before the twenty-fifth annual convention of the American Foundrymen's association held in Columbus, O., the week of Oct. 4-8, 1920. The author, Lieut. R. F. Nourse, is attached to the United States navy.

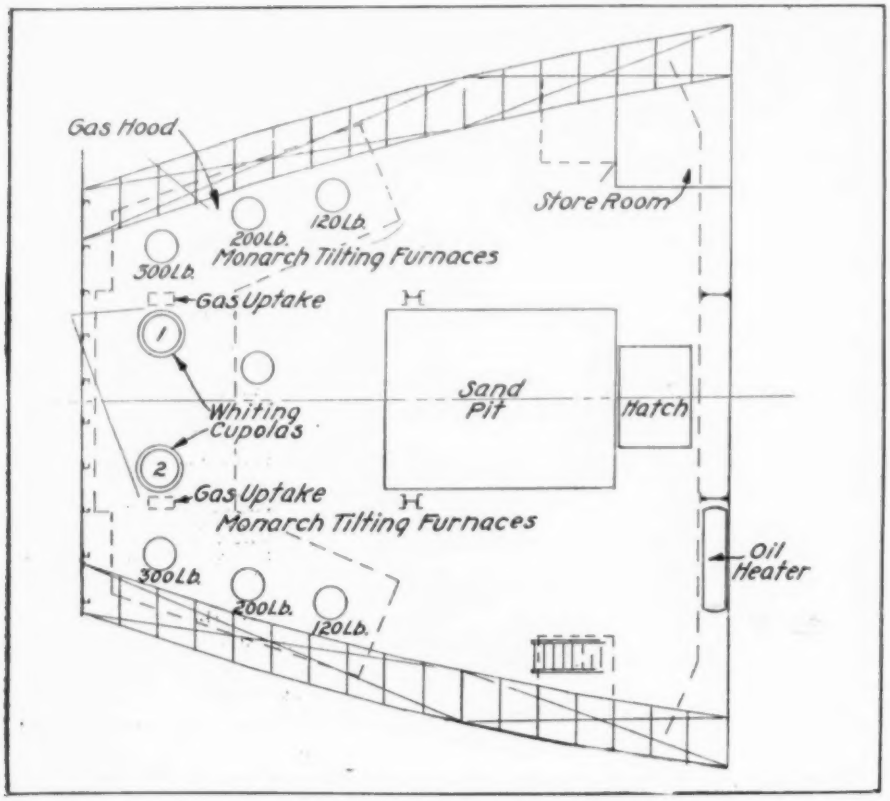


FIG. 3—FOUNDRY FLOOR SHOWING LOCATION OF THE MELTING UNITS

pit, 6½ x 14 x 18 feet, used for making large castings. The rest of the space below the platform deck and around the sand pit is used as a metal store room.

Well Ventilated

The center of the foundry is open to the main deck and is there covered by a portable hatch which furnishes ventilation for the gases when pouring. The lower deck is ventilated by means of electric blowers.

A gallery extends around three sides of the foundry at a height of the berth deck. On the starboard side of this gallery are two core ovens, a work bench for the coremakers and electric blowers for the cupolas. Across the after end is the loading platform for the cupolas and on the port side but in a separate compartment is the pattern shop. This is equipped with the tools necessary in making patterns. The entire gallery has a floor space of 1750 square feet. In the hatch over the center is an electric traveling crane of 3 tons capacity which runs the entire length of the foundry and handles the metal as well as the castings.

The winches and booms on deck are used for lifting weights to the deck, and also can take anything from the lower platform deck and place it in a boat alongside the ship. These booms are of 10-ton capacity.

While at Brest during the war the foundry reached its greatest output. The following table gives the output by months during that time:

Month 1918	No. of iron Castings	Total weight
March	156	7782
April	112	4625
May	323	17342
June	282	10177
July	261	11287
August	422	22251
September	393	20166
October	829	36078
November	1359	59589
December	1144	45090

Month 1918	No. of composition and brass castings	Total weight
March	132	1133
April	225	3295
May	384	2975
June	328	3503
July	483	4292
August	546	9075
September	810	5188
October	815	5980
November	518	4302
December	602	5979

Month 1918	No. of patterns made	No. of core boxes made
March	81	28
April	68	18
May	76	23
June	72	23
July	121	31
August	120	28
September	102	24
October	103	31
November	92	27
December	49	45

It will be noticed that in November, the month of the armistice, the output of iron castings was at the maximum.

The work completed by the foundry covers a large list of castings used in marine practice, but among work accomplished may be mentioned pistons, cylinders and manifolds for motor boats; pistons and slide valves; angle and globe valves; pump cylinders; valves and liners; and piston rings of all sizes. The largest casting was for 73½-inch diameter low-pressure piston ring for the U. S. S. ROCHESTER. Pistons of various sizes were made, the largest being a bull ring of 44 inches diameter for the U. S. S. SOLACE. All castings used in converting the boilers of the PROMETHEUS from coal to oil burners and the fitting of the center line double bottoms for oil storage were cast on board ship. Metallic packing of various kinds and bearings of various sizes and types also were produced. For many of these the patterns had to be made. The largest single iron casting weighed 2100

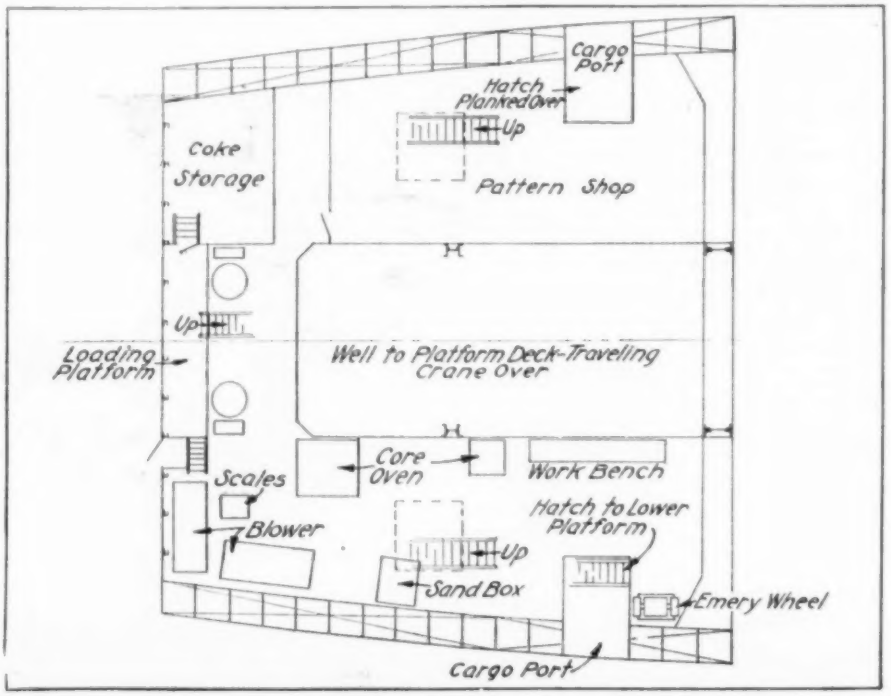


FIG 4 —A GALLERY EXTENDS AROUND THREE SIDES OF THE FOUNDRY AT THE HEIGHT OF THE BERTH DECK

pounds and was for a bending slab for the welding shop, and the largest composition casting was for a main shaft steady bearing for the U. S. S. DELAWARE. This weighed 900 pounds.

The general superintendent of all of the shops is an officer, while the working personnel of the foundry consists of enlisted men. The master molder is a chief special mechanic—the highest rating of an enlisted man. His assistant is a special mechanic, first class, and the skilled men are molders, first class, and molders, second class, rated according to their ability. The helpers are rated as firemen who may become molders second class when they have gained the experience necessary and proved their ability by passing an examination which covers practical work.

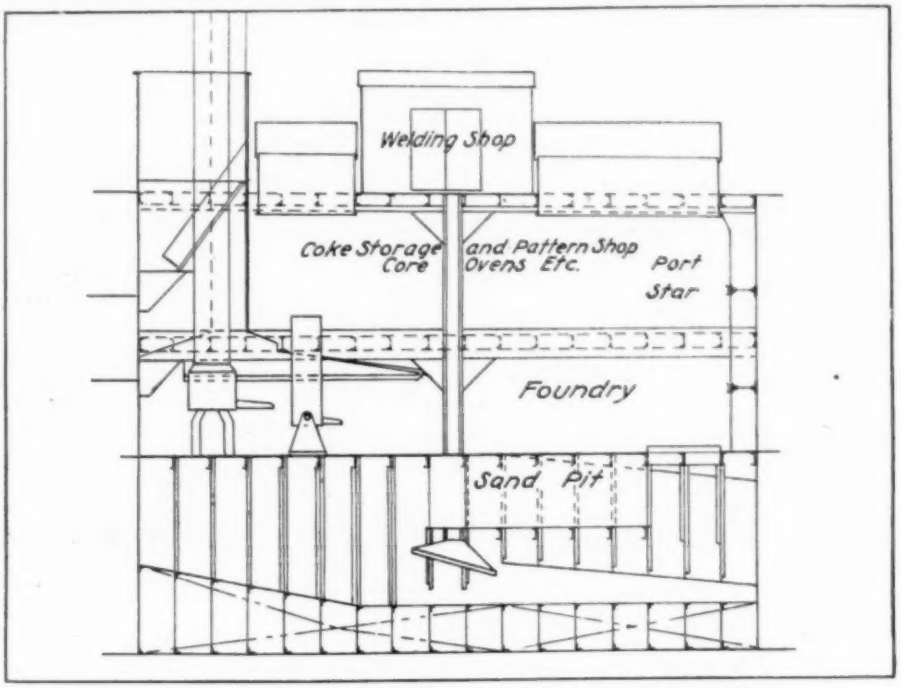


FIG. 5—ELEVATION OF FOUNDRY ON BOARD U. S. S. PROMETHEUS

Urges Conservation of Oil Supply

GIVING a world view of the oil supply of nations, George Otis Smith, director of the United States Geological survey, in a recent address before the American Petroleum institute, declared the oil problem can only be solved through a keener realization of the world's future needs and a stronger determination to serve future interests. He strongly urged a program of conservation, asserting that the world has not enough oil as a source of motive power for its railroads and industries. Mr. Smith said in part:

"The United States Geological survey's estimate of the petroleum resources of the world shows that the distribution, while unevenly balanced among nations, is evenly balanced between the eastern and the western hemispheres.

"More than half the world's oil reserves are believed to be concentrated in two intercontinental areas; one of these oil-rich provinces includes the North American and South American countries bordering the Caribbean sea, and the other includes the countries of western Asia and southeastern Europe, with the Caucasus as an axis. On these two areas then, comprising together only about 4 per cent of the earth's surface and containing about 60 per cent of the world's future supply of oil, is focused the attention of the great nations that most need oil.

"Granted, then, that we have not enough oil to permit its use where either coal or water power can be had, we face the question of priority in use. First in any priority list must stand essential uses in which there are no adequate substitutes. In view of the rapid increase in the employment of machinery first thought should be given to the unique function of oil—that of saving power. The world will always need a supply of lubricants, and as the demand will be an increasing one, no adequate substitute for the lubricating oils and greases now derived from petroleum appears to be available. The kerosene lamp and even the fixtures burning oil, gas or enriched water gas, must eventually give place to the electric light.

"The real competition comes in the relative claims of automotive gasoline and of fuel oil, for the larger yield of gasoline through more efficient cracking, is gained at the expense of the fuel oil content of the crude oil. These two uses are already rivals, and we may expect refinery practice to be responsive to the automatic control of prices, which in turn, ought to express relative demand.

"The 'flash point' in any discussion of priority in the use of petroleum products, is reached when any curtailment in the use of gasoline by pleasure automobiles, is suggested. Yet by every known rule of determining priority, the nonessential use is the first to be regulated, and this use of a petroleum product as a luxury can find no economic justification in comparison with its various commercial uses.

"In September of this year, as in August, the daily output of the United States oil wells was slightly over one and one-fourth million barrels, but the daily consumption rose to one and five-eights million barrels. This daily deficit of three-eights of a million barrels was met by imports from the Mexican oil district."

Will Standardize Mining Equipment

The American Engineering Standards committee has assigned to the council and the American Society of Mechanical Engineers jointly the sponsorship for a standard color scheme for pipe lines in power plants and factories. The council also has been asked to take a leading part in the standardization of mining equipment and practices, with special reference to safety as applied to mining in its various phases.

Welding Company Appoints Sales Agent

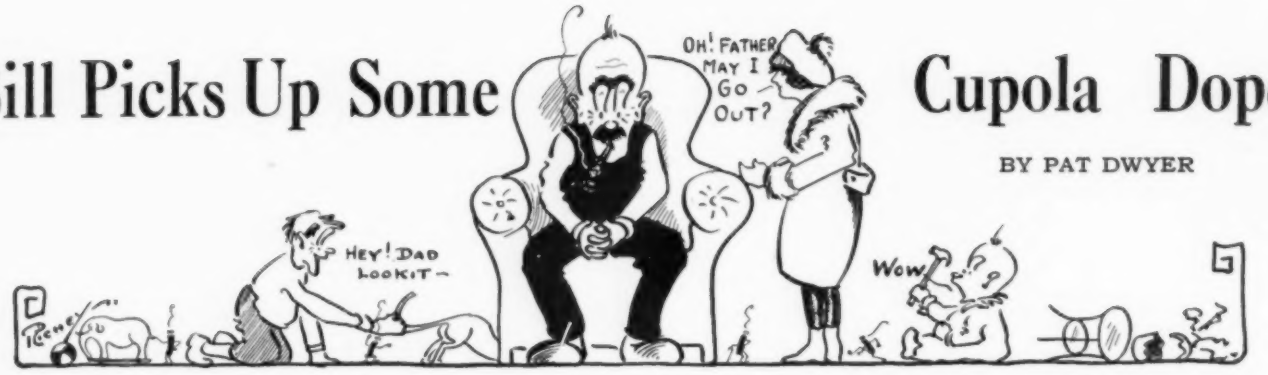
The Standard Supply & Equipment Co., New York and Philadelphia, has been appointed eastern sales agent for welding and cutting apparatus and supplies manufactured by the Oxweld Acetylene Co. The company has appointed George E. Temple in charge of its welding and cutting equipment. Mr. Temple formerly was connected with the Prest-O-Lite Co.

Organizes Foundry Supply Company

To manufacture and deal in foundry supplies is the purpose of the Mac Co., Milwaukee, which recently was organized by W. J. Adams, formerly of the S. Obermayer Co., Chicago, and John R. Cummings, formerly of the same organization. The company has opened a plant at Thirty-fourth and National avenues, West Milwaukee, Wis. Parting, plumbago, core oil and similar materials will be manufactured at the start.

Bill Picks Up Some Cupola Dope

BY PAT DWYER



MANY years ago when I had more money and less sense than I now have,—need I say it was before I was married—I was a member in good standing of several more or less fraternal orders. The fact that I was a member of so many societies is *prima facie* evidence that I had lots of money and the fact that I attended all the meetings and took an earnest part in all the discussions, might be taken to prove that I did not have much sense. I will not go so far as to say that the experience exerted a life-long influence on my character, either for good or evil. However, I will admit that the practice gained in debate and occasional slight bickering with my brother members has stood me in good stead in recent years when I have been asked to take the chair temporarily to preserve order while the regular chairman has been attending a movie. Before leaving the house, she would give me the most complete and minute instructions on what to do and how to do it under any and all circumstances, particularly in regard to the baby—come to think of it now there always has been a baby in the house—and then I would find myself alone among a band of animated young talking machines, any one of whom could ask more questions in an hour than a strong man could answer in a life time.

As nearly as I can figure it out, the modern system of education is designed to relieve the teacher of as much worry as possible. The children are supposed to find out everything and solve all their problems at home. The teacher then will be graciously pleased to examine the work. If it is correct, credit marks are given; while, if it is all wrong, instead of explaining the trouble, the child is told to try it over again as home work. 'Tis a great system, and it is no wonder that so many of the pupils develop such extraordinary skill in after life, in passing the buck.

The seance was just under way on a recent occasion of this kind when Bill poked his long jib-boom nose through the front door and came to an anchor in our midst. He pooh-poohed my bitter remarks touching on the difficulties experienced by children in these modern days, getting an education and some of the apparently senseless problems they were given to solve.

"Let them work them out," said he. "It will do them good and help them in solving some of the real problems which are bound to confront them in later life. I was up against a problem in my early foundry career which has caused many

I'LL TELL YOU WHY YOUNG FOUNDRYMEN BITE THEIR NAILS

a young foundryman to bite his nails. It seems simple enough now, and I often wonder why the obvious solution did not occur to me without having to appeal to a master hand in the foundry game. The problem resolved itself into a question why a certain cupola did not deliver more and hotter iron.

"This 60-inch cupola never had given satisfaction. By that I mean that while the iron was hot enough to pour the heavy work, it was not hot enough to pour the light castings on the side floor. Of course, they were poured in a kind of a way; but the ladles always were bunged up before the heat was over. The cupola also melted too slowly, about 20,000 pounds an hour was her limit. It had been built on the premises by the company's own boiler makers and patterned after a standard model made by a certain cupola manufacturer. Instead of a wind box built-on and forming an integral part of the shell, the cupola was provided with a bustle pipe and a set of 8 pendant tuyeres like a blast furnace.

"The blast was furnished by a positive pressure blower, housed in a brick building erected for that purpose with a screen across the blower intake to strain the air. Everything about the cupola apparently was all right; but it simply would not deliver the iron. It was regarded as a kind of a hoodo and only used when the daily melt exceeded 50,000 pounds. A second cupola, lined to 48 inches and supplied with air by a centrifugal fan driven by a 25-horsepower motor, was employed for all heats up to and including 50,000 pounds. Some one had said at one time that a 48-inch cupola would not melt more than 25 tons and for more than a period of 10 years no one had the temerity to try and disprove the statement. I merely cite this statement at this time to illustrate the conservatism which obtained and still obtains to a certain extent among foundrymen. There are exceptions; but it is a well known fact that the majority of foundry foremen hate to meddle with the cupola. If it is supplying satisfactory iron when they take charge of a shop they take it as a matter of course and if the iron is not all that it should be, they blame everything from the state of the weather to the condition of the coke—with the latter a 5 to 1 favorite. They calmly refuse to hold themselves responsible. For ways that are dark and for tricks that are vain, there are foundry foremen who have the heathen Chinee backed right off the map.

"Indeed, if the whole truth were known, you hardly can blame them. There are owners of foundries who cannot be convinced that their equipment is not perfect. If a badgered and be-

devilled foreman were to put the issue squarely up to the owner and claim that the motor or fan was too small, or that the blast pipe or tuyere area was not in proportion to the rated melting capacity of the cupola, he would be told that the outfit was all right and that if he knew his business, he could make it work.

"However, this is not a monograph on the subject of melting in general, so I will just confine myself to the specific case about which I started to tell you. As I said, this 60-inch cupola had been in use intermittently for about 10 years, and eight or ten foremen had charge of the shop for varying periods during that time. About this time, by the grace of God and a fluke of fortune, I found myself appointed to the position of assistant foundry superintendent. The super and I, at one time in our career, had worked together on the floor and consequently in our new relationship, we were perhaps, more intimate than would be the case under ordinary circumstances. We often discussed this peculiarity of the 60-inch cupola, and even tried some experiments by changing the relative proportions of coke and iron in the charges. Without changing the position of the bustle pipe, new tuyeres were cast with a bend in them designed to enter the cupola at first lower down and then higher; but neither charge affected the heat of the iron or the speed at which it melted.

"I don't know where our investigations eventually might have led us, or how long it would have taken us to solve the problem, for frankly, we did not know much about it, but circumstances forced our hand. Changed conditions made it necessary that we melt from 40 to 50 tons a day, and that meant that the 60-inch cupola would have to be used every day. The saying that the Lord tempers the wind to the shorn lamb, was exemplified in our case. Before the wind began to blow too hard and while we were just doing a little preparatory shivering, we were fortunate enough to get in touch with a man who had been engaged for years in taming cupolas until he could get them to come up and eat out of his hand.

"Talk about your 'rock in a weary land and a shelter in a time of storm.' He was all of that, and more to us. He did not say he would come around some day and look over the situation and then render a verdict. Not at all. He simply said: 'Tell me the inside diameter of the cupola, the combined tuyere area, the rated capacity and speed of your blower, and I'll tell you what is the matter with your old white elephant.'

THE EXPERT'S SPECIALTY WAS MAKING THEM STEP LIVELY

"Well now, do you know, neither of us could give that data off-hand. In common with our predecessors, we had taken it for granted that the men who had installed the equipment in the first place, knew their business and besides, since the basic principles underlying the melting of iron never before had been put up to us for solution, we had failed to familiarize ourselves with them.

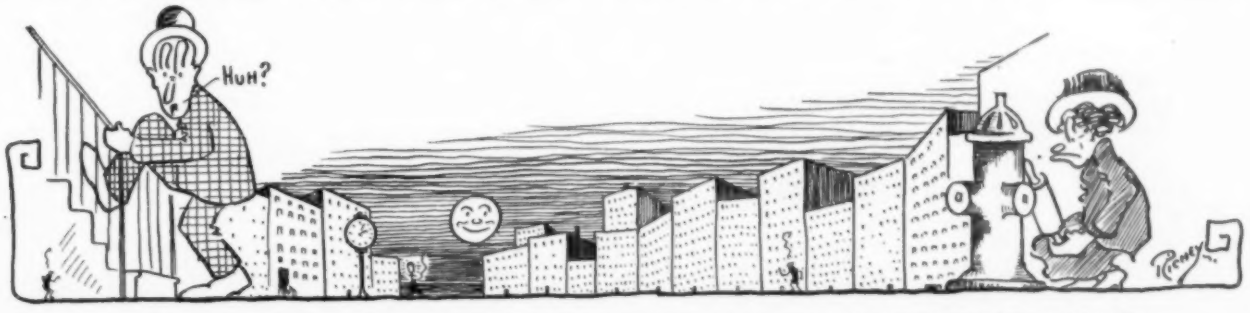
"On the following day we went into the cupola after the cupola man had picked her out and measured the diameter of the tuyeres. We found that there were eight of them, each six inches in diameter. We discovered that the main blast pipe was 15 inches in diameter, and finally found that the blower connected to a 35-horsepower motor, had a rated capacity of 28.2 cubic feet per revolution, and was geared to run at 180 revolutions a minute. We submitted this data to the expert and he threw up his hands in holy horror.

" 'It is a wonder to me' said he, 'that your old cupola melted any iron at all. Your blower, blast pipe and tuyeres are all too small. A cupola should melt about 10 pounds of iron an hour for every inch of horizontal area at the melting zone. Of course, this amount will vary to a certain extent, depending on a number of factors like the character and size of the pieces of iron forming the charge, and the temperature at which it is desired to tap the molten iron. However, in your case, 10 pounds an hour is a fair average and therefore your 60-inch cupola with an area of 2827 square inches, should deliver between 14 and 15 tons an hour.

" 'Without entering into the technical aspects of the question dealing with the chemical reaction which takes place when the oxygen of the blast unites with the carbon in the coke and the theoretical amount necessary to complete combustion, and therefore the most intense heat, it will suffice for all practical purposes to say that it requires 30,000 cubic feet of air to melt one ton of iron. When you know how many tons of iron a cupola is capable of melting in an hour, and also how many cubic feet of air are necessary to melt one ton, it is only a simple sum in multiplication to compute how many cubic feet of air are necessary to melt any quantity of iron in a given time.'

" 'In your case, you need a blower capable of delivering at least 15 times 30,000 cubic feet of air an hour and you also need a blast pipe and set of tuyeres through which this air can be delivered at about 14 or 16 ounces pressure. Pressure is only an incidental factor after all. Volume is the main consideration. However, too high a pressure must be guarded against since it has a tendency to drive the air through the bed of fuel too rapidly for complete combustion. That is the main reason for providing a generous blast pipe and set of tuyeres.'

"The dope sounded reasonable, and when it was laid before the master-mechanic, he promised to attend to the matter without delay. It was his first job as a master mechanic, and he had been doing a little worrying on his own account on how to meet the increased production demanded from the foundry. He had a big fan hauled up from the calcining building near the open hearth, where it had been for several years,



HE IS IN A FAIR WAY TO VERIFY THE STATEMENT THAT GOOD INTENTIONS ARE USED FOR PAVING BLOCKS

after it was discovered that the kilns for calcining the dolomite worked satisfactorily under natural draft. The fan was connected by a practically unbreakable belt to an 80-horsepower motor, similar to the one in use on the cold-saw in the rail mill. A 24-inch pipe with suitable connections leading to the two cupolas was connected to the outlet of the fan. Sliding blast gates were inserted at two points in the pipe, making it possible to divert the blast to either cupola, or if necessary, to operate them both at one time. The 6-inch tuyeres were taken out and replaced with a set of square tuyeres 8 x 8 inches.

"The master mechanic pointed out that the blower and motor were capable of delivering far more air than was necessary; but he said it was only a good safety factor and let it go at that. The result truly was surprising. The furnace was newly lined for the first time, and we rigged up a water gage made of two pieces of glass tube connected at the bottom with a piece of rubber hose to test the pressure. With the gate wide open, that old fan registered a pressure of 24 ounces, and blew a column of flame and sparks out through the top of the stack. The gate then was partly closed until the gage showed a pressure of 15 ounces and at that the furnace melted at the rate of 32,000 pounds an hour. A few days afterward when the lining had burned back 3 or 4 inches, she delivered iron at the rate of 35,000 pounds an hour and hot enough to pour anything. We had no more trouble after that and, mind you, we ran some pretty heavy heats. On one occasion, we melted 85 tons and that is quite a gorge to put through a 60-inch cupola in one day. She melted at a uniform speed all through and dropped as clean as if it had only been 30 tons."

"Well," said he as he arose and looked at his watch, "I guess they are dropping the bottom down at the Alhambra about this time and I had better hustle home and punch the clock before the manager gets back."

British Foundry Industry Facing a Crisis

Lord Weir, speaking before a meeting of the Scottish section of the Institute of Metals at Glasgow said that at no time in the history of the country was the subject of production in general of such vital importance as it is today. Referring specially to the production of British foundries he said that it was rather a depressing fact that due to many causes the production of engineering commodities for the world's market in the post war period had fallen lamentably behind the demand from that market.

They had experienced and were still experiencing the extraordinary phenomenon of a shortage of castings in a great engineering country. The engineering industry had suffered and was suffering severely from the influence and interactions of that phenomenon. During the war there was a vast expansion in the machinery and assembling capacity through the erection of great machine shops and the vast installation of machine tools required for munition work. They were largely employed on steel products and now in peace time they were turned over to requirements which demanded production in iron and brass. This condition caused a lack of balance, of machining and assembling facilities standing idle and the resulting restriction of employment.

The condition could be remedied by the rapid provision of new foundry facilities and by the conversion of certain types of war shops into foundries. This process had been carried out to a substantial extent. However, facilities by themselves were insufficient. Labor was required and here was to be found a parallel to the ill-balanced facilities.

In Lord Weir's opinion there are only four methods for increasing the volume and efficiency of production in any industry. (1) An increase of intensity of effort per operative hour. (2) An increase in the number of operative hours per individual per day. (3) An increase in the number of operative individuals. (4) A perfection of methods, processes and organizations to eliminate waste of operative hours.

He disregarded the first two as being unsuitable for discussion; he dealt very shortly with No. 3 and practically confined his attention to No. 4, which might be taken to represent the vital responsibility of the foundry employer and management. The present unsatisfactory position of the foundry industry to a large extent was the fault of the employer's past policy. That policy was the fairly universal failure to appreciate the important necessity and great possibilities of precise accurate and scientific methods in the foundry. During the past few years there had been a considerable enlightenment on the part of employers in this connection and all that was required at the present stage was the recognition of that enlightenment by the trade unions and of elasticity of their policy and a sympathetic co-operation on their part.

Referring to the importance of the planning department of a foundry Lord Weir pointed out that there existed a great necessity for a knowledge of foundry practice. Obviously the design and construction of a pattern and equipment for the production of one casting would be radically different from that required for mass production. After dealing exhaustively with the technical side he touched on the commercial aspect of the problem. He claimed that the necessity for increased and economical production makers the subject of foundry costs of prime importance.

Establishes Consulting Firm in Chicago

A. A. Wickland, formerly connected with the Crane Co., Chicago, Campbell, Wyant & Cannon Co., Muskegon, Mich., and other prominent firms, has recently returned from a trip through Europe as consulting engineer for a European banking syndicate. His efforts were largely devoted to the development of malleable, gray-iron and brass foundries, and the introduction of American machine tools and manufacturing methods. Mr. Wickland now is retained as consulting engineer for several American and European manufacturing concerns. To carry on this work, C. B. Teeter, G. F. Schreiber and others, are associated with him under the firm name of A. A. Wickland & Associates, engineers, with office at 105 West Monroe street, Chicago, and are specializing in the layout, architectual design and construction of complete foundries and manufacturing plants.

Hadfields Erects a New Steel Foundry

Hadfields, Ltd., Sheffield, England, is erecting an additional foundry for the production of small steel castings. Sir Robert Hadfield states that this will employ 1000 additional men. The extension covers 12¼ acres, and the roof area is 7½ acres. Electric tractors are used for haulage. Small steel castings will be made for coal mining and other industries. The foundry includes core and drying ovens, molding machines, a complete sand handling department, with sand mixing machines and grinding mills. Sixteen furnaces for heat treatment are the raised bottom and roller bottom type. Quenching tanks and modern sand blast are provided. The crane equipment includes a traveling 10-ton crane, and a 7-ton stationary electric jib crane. The foundry will be supplied with a 2-foot gage inter-shop railway.

The American Dressler Tunnel Kilns, Inc., has moved its executive and engineering offices to 1740 East Twelfth street, Cleveland.

Anneal Steel with Pulverized Coal

Carbon and Sulphur from the Fuel Penetrate the Annealed Metal to Varying Depths—Sample Bars Annealed Several Times Indicate the Limit of Absorption for These Elements

BY C. H. GALE

THE use of pulverized coal in the foundry has been the subject of many articles in recent years, and the annealing of steel castings has had its share of attention of those interested in the industry. Results of annealing steel castings with pulverized coal are tabulated in their paper.

For a number of years, steel castings in the foundry where these investigations were conducted had been annealed with natural gas or oil. After the installation of a pulverized coal plant and the use of this coal for annealing had begun, a marked difference in the physical characteristics of the steel was noticed, the

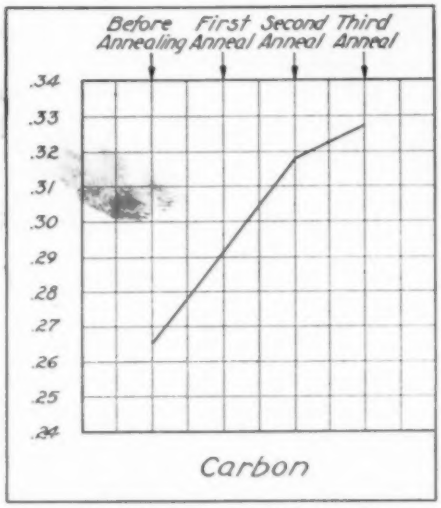


FIG. 1—INCREASE IN CARBON CONTENT IN STEEL ANNEALED WITH PULVERIZED COAL

tensile strength being greater with the elongation and reduction in area and the results of the bend tests less than had formerly been obtained from heats of the same analysis and annealing temperature. No other condition being in evidence which would cause this change, attention was directed to the fuel used and after an extended investigation it was discovered that the carbon and sulphur content was considerably increased when using coal as fuel, the average analysis for a number of heats being: Carbon, before annealing, 0.262 per cent; after annealing, 0.287 per cent; sulphur, before annealing, 0.287 per cent,

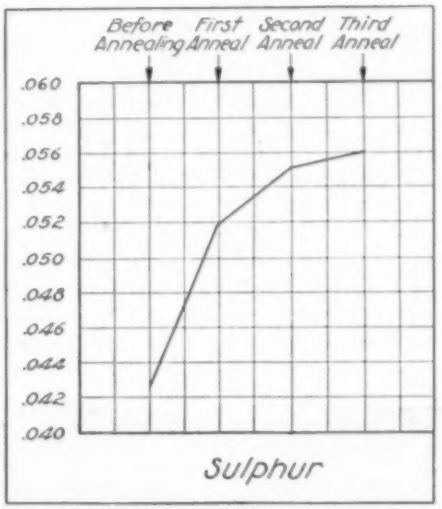


FIG. 2—INCREASE IN SULPHUR CONTENT IN STEEL ANNEALED WITH PULVERIZED COAL

and after annealing, 0.052 per cent.

The coal used was high in sulphur, ranging from 2.45 to 2.80 per cent. In order to ascertain the effect of repeated anneals on the carbon and sulphur content of the steel, test pieces were subjected to three anneals, the analysis before and after each anneal being as follows:

		After		
	Before Annealing	First Anneal	Second Anneal	Third Anneal
Carbon	.262	.287	.310	.330
	.259	.283	.308	.320
	.272	.294	.317	.329
	.267	.299	.324	.325
Average	.265	.291	.317	.326
Sulphur	.043	.052	.055	.056
	.044	.054	.056	.057
	.041	.050	.054	.055
	.042	.052	.055	.055
Average	.0425	.052	.055	.056

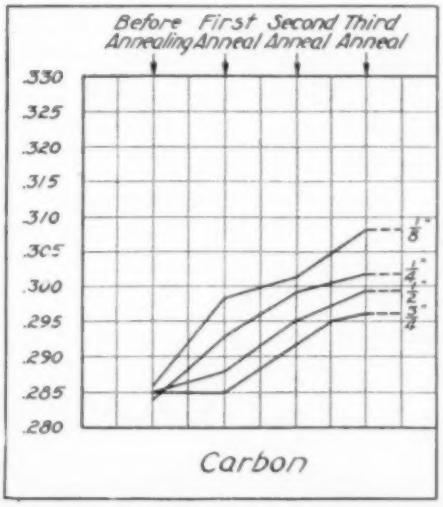


FIG. 3—CARBON CONTENT AT VARIOUS DEPTHS AFTER ANNEALING WITH PULVERIZED COAL

By referring to Figs. 1 and 2 it will be noted that these elements, particularly sulphur, took a rapid increase at the first anneal. The increase at the second anneal was considerably less while the gain after the third anneal was negligible, indicating that the metal had at the second anneal absorbed about all of these elements it could from the fuel.

The thought having occurred that possibly the fuel had a case hardening effect upon the steel, test bars 1½ inches square were made and from these drillings were taken ⅛, ¼, ½ and ¾ inch from the surface for analysis with the following average results:

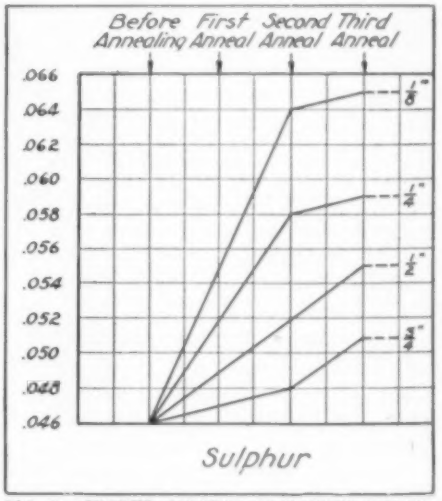


FIG. 4—SULPHUR CONTENT AT VARIOUS DEPTHS AFTER ANNEALING WITH PULVERIZED COAL

	⅛ in.	¼ in.	½ in.	¾ in.
Before annealing	.286	.284	.285	.285
After first anneal	.298	.293	.288	.285
After second anneal	.301	.299	.295	.295
After third anneal	.308	.302	.299	.296
Sulphur—				
Before annealing	.046	.046	.046	.046
After first anneal	.055	.052	.049	.047
After second anneal	.064	.058	.052	.048
After third anneal	.065	.059	.055	.051

As will be seen by the results given above, and as shown in Fig. 4, the increase in sulphur was less the farther below the surface the sample was taken, and that the same applied to the carbon, Fig 3, but not to such a pronounced degree. In other words, the increase in both sulphur and carbon is considerably near the surface, but decreases as the depth below the surface increases. Even when sulphur in the sample was comparatively high more sulphur was gained by an anneal using powered coal.

Paper read at the American Foundrymen's convention, Oct. 6, 1920, by C. H. Gale, Pressed Steel Car Co., McKees Rocks, Pa.

Furnace Earns Cost in Two Months

Homemade Electric Furnace of Simple Construction Operated Producing Synthetic Pig Iron from Steel Scrap—Only a Little Longer Than a Month Required to Build It

BY HERSCHELL L. HATT

RECENTLY, the shortage of low-phosphorus pig iron led the Trumbull Electro Metals, Inc., St. Catherines, Ont., Can., to build an electric furnace for the production of synthetic pig iron. Whether synthetic pig iron could be produced economically from steel turnings by the electric furnace, was somewhat of an experiment. Considering the proposition from all angles, it did not appear desirable to spend more money than wou'd be absolutely necessary, because it seemed that the urgent demand for this grade of iron would not long continue. The company was successful in keeping the total cost of construction so low that this homemade furnace, practically fabricated and built on the job, paid for itself in two months. Its general appearance may be judged from the accompanying illustration. A furnace of this kind is especially interesting because it can be adapted not only to synthetic pig iron but can be used for gray iron. malleable, and other products, such as 15-per cent silicon iron. The furnace had a capacity of 5 tons. The outside shell was made of ¼-inch boiler plate at a local boiler shop. It was 5 feet 5 inches high and 10 feet in diameter. The joints all were riveted. An opening was cut 15 inches from the bottom for the tap hole. Other openings, for charging doors, were made on each side, 34 inches from the bottom. A 10-inch roof ring was fabricated separately so that it could be lifted on the furnace after the roof was bricked in it. This ring had a flange around both the top and bottom to hold the first row of brick. When laying the brick, the ring was set over a concrete, dome-shaped, base form so that the rising circles of brick would be uniform, templates being used for the three electrode holes. The first roof was a failure. The center had an arch 5 inches high but this was not enough. The next roof was given a 9-inch rise and was successful. The furnace shell was set on a concrete base, with a concrete loading platform on both sides, each platform being about 10 x 15 feet.

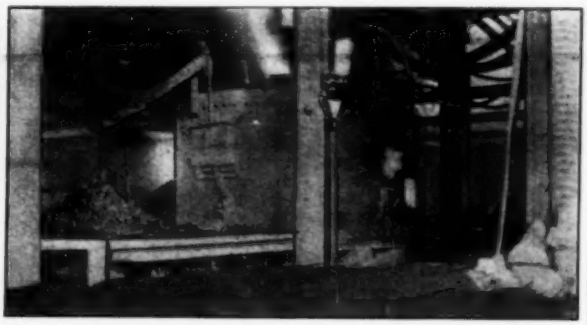
Bottom of Carbon Blocks

One layer of firebrick was laid flat on the bottom of the shell. The crevices between the brick were all filled with a mixture of hot tar and burned dolomite. Originally carbon paste was used, but this lifted and allowed the bottom to come up. However, after the mixture of dolomite and tar was used no trouble of this kind was encountered.

A layer of square carbon blocks 16 x 16, odd lengths, was laid above the bricks and also around the sides thus forming the crucible of the furnace. Silicon brick blocks, square and wedge-shaped to conform with the circle, were laid above the ring of carbon blocks. The charging doors and tap hole were arched with silica brick. Before setting the roof, a thick layer of silica cement was placed around the top of the furnace wall, so that the roof brick could be set in it to stop any opening or crevice which, if started, would be quickly eaten away by the flames. One of the most important points to watch in lining an electric furnace is to see that no crack or crevice appears where the flame will cut its way through. A small opening will ruin in two or three days a lining that would otherwise last a month. The crucible being formed entirely of carbon was neither basic nor acid but neutral. But after the furnace had been in operation a while the carbon blocks wore away considerably and dolomite was then used to fill in and preserve the bottom which was changed from neutral to basic by the dolomite. While the furnace was being lined three transformers were installed. These were each 300 kilovolt amperes, 12,000 volts. 3 phase, 25 cycle, with delta connection. The electric current came in on the high tension lines at 12,000 volts and was transformed to register 100 volts on the secondary at the furnace. The higher the voltage at which the electric current travels, the smaller the medium will be that is required to carry it. This explains why a small wire will carry current at 12,000 volts into the plant, while a busbar ⅜ x 6 inches was required to carry the same amount of power at 100 volts, to the furnace.

The high tension line was protected by a lightning arrester of simple construction. It consisted of three barrels filled with water and grounded by wires into a pit filled with stone and coke. In case the lines were struck by lightning the excess load would be carried away by the arrester through three horn gaps each between one of the barrels and one phase of the lines. Three choke coils were also connected in the line as a further protection for overload.

One night during a storm, after the furnace had been running for sometime and before lightning arresters were installed, there was a roar and the switch was immediately tripped. The next morning a hole was found in the



THAT synthetic gray iron can be made from steel turnings under certain market conditions has been proved as detailed in this article which gives an account of how an electric furnace was constructed at a comparatively low cost to keep down the overhead expense, and paid for itself in two months. While this furnace has since been abandoned on account of difficulty in securing electrical power for it another furnace of similar design has been erected at Shawinigan Falls, Que., and is still in operation making foundry pig iron and gray-iron castings synthetically.

The author, Mr. Hatt, was works manager of the Trumbull Electro Metals, Ltd., at the time the furnace was installed.

core of one of the transformers, about as large as a man's fist. Lightning being freakish, had hit this one without any damage to the others. It took three weeks to get it repaired. In the meantime the furnace was run with the two transformers, open delta, using about 600 kilowatts. Production dropped to about half under this method of operation.

The current was cut in or off by three large knife switches opened and shut with a wooden pole. Current transformers were placed following the disconnects, reducing the flow of amperes from 60 to 5 to suit the coils in the metal and regulators. A small oil switch was set on a stand with the grip in the furnace room. This switch would trip and throw out on an overload in the furnace. It was handy to the furnaceman and he could throw off the current in a moment.

The high tension or primary wires were connected to the transformers and the busbars were fastened on the secondary side. The busbars extend far enough through the wall to allow copper cables to be clamped to them. These cables were flexible, so as to follow the movement of the electrodes up and down in the furnace. Regulators were installed to control the motors running the winches, which raise and lower the electrodes in the furnace. As the consumption of power was figured on the peak load held for one minute, these regulators were very important. They kept the current constant at the point for which they were set. The furnace ran at times, two and three hours, without a man on the hand controls.

The electrodes in the furnace and the flexible cables were suspended from overhead by wire cables. These cables ran over sheave wheels, supported by channels and I-beams, down to the winches. The motors on the winches were operated by direct current, so that they would stop and start instantly in response to the regulators. A small generator set was secured to transform the alternating current to direct current for the motors. It was thought to be feasible to use alternating current motors with magnetic brakes, but as the generator set didn't cost much, it was considered advisable to produce the direct current.

Cooling rings were placed on the furnace roof around the holes through which the electrode passed. These rings were made of cast iron, shaped to conform with the slope of the roof, the holes being perpendicular. With rings of this design it was not necessary to build up one side of the cooling ring with brick, to level it and allow the electrode to pass up and down freely. More important still, the advantage of the cooling ring was to keep the circle of brick under it cool and if the cooling ring had not been in close contact with the circle of brick, the advantage of cooling would have been lost. As these brick circles were held together like an arch, one brick getting loose meant that the whole circle would fall, therefore, the importance of protecting them Water passed through these cooling rings and flowed into a funnel shaped receiver at the side of the furnace. This was arranged so the furnaceman could always see that the water was running, cooling each leg in the furnace.

Sometimes a cooling ring would start a leak. Spares were kept on hand and used while the leaky one was welded with an acetylene torch. It was very difficult at first to get a good weld, but by preheating the whole casting till it was red hot and then applying the torch, they were successfully repaired. The three electrode holders were water cooled as well, the same water under city pressure first passing through the holders and then through the cooling rings. The pipes were connected with rubber hose to allow for the raising and lowering movement of the electrode holders.

Various Insulation Tried

Cables for raising and lowering the electrodes were attached to the electrode holders with eye bolts. A cable was connected on each side of the electrode holder. The cables ran over sheave wheels on the structural work above to a yoke fastened with a turn buckle, so that they could be lengthened or shortened to properly balance the electrode.

The eye bolts were insulated from the holder with an insulating washer on each side of the hole in the holder and an insulating tube through the hole. Sometimes these would break down and burn off. High tension strain insulators were tried, but these invariably cracked under the intense heat. By protecting the insulation from the flame as much as possible and by close inspection undue trouble was avoided.

Cast-iron frames were made for the charging doors which were lined with silica brick and operated by counterweights. A notch was made on each side of the door frame and a bar was placed through these notches to hold the door tight against the furnace, thus preventing the flame from coming out and eating away the brick and shell.

The first charge was tapped only a few days over a month from the day construction was started. The working force was divided into two shifts, eleven hour day and thirteen hour night. The shifts changed about every two weeks. Nine men were detailed to each shift as follows: One furnace man, one helper, three shovelers and four men to make molds and carry out iron.

Each heat was made up as follows:

10,000 pounds steel shell turnings.
600 pounds charcoal.
250 pounds 50 per cent ferrosilicon.
300 pounds lime.

It was charged in the following manner:

1st (a) 25 per cent of the lime on the bottom.
(b) 50 per cent of the charcoal.
(c) Balance of space with shell steel turnings.
2nd (a) Lime.
(b) Turnings and charcoal mixed.
3rd Half an hour before tapping, the ferrosilicon was charged.

The composition of the iron was, carbon, 3.15 to 3.50 per cent; silicon, 1.25 to 1.50 per cent; manganese, 0.60 to 0.70 per cent; phosphorus 0.03 to 0.04 per cent; sulphur, 0.012 to 0.020 per cent. It usually took from 3 to 4 hours to melt, depending on the voltage which at times was low. The day power load was 900 kilowatts and the night power load 1060 kilowatts. On Sundays and holidays the load was 1050 kilowatts. On account of the lower power secured during the day, the running schedule was two heats each day, while three heats were made each night and six heats on Sundays and holidays. For the first six months 2995 gross tons of iron were produced with an average consumption of 534 kilowatt hours per gross ton.

While in these times of changing costs and wide variables from one section of the country to another, the gross cost may not be of much value. However, the relative costs of different operations will enable anyone to calculate closely what the cost would be in any section. These were found to be as follows:

General and office expense	$ 1.63
Raw materials:	
Carbons	2.19
Coke and coal	.25
Charcoal	1.11
Fluor Spar	.46
Ferrosilicon	2.02
Lime	.34
Sand for molds	.30
Scrap	15.36
Total material cost	$22.03
Manufacturing:	
Wages	$ 5.90
Repairs	2.12
Shop expenses	.34
Power	4.63
Oil and waste	.01
Repairs to buildings	.05
Water	.09
Total manufacturing cost	$13.14
Total cost per gross ton	$36 80

Means for handling the stock were arranged with as little cost as possible. Turnings were unloaded from the cars along the track. A small industrial track was laid from the charging platform to the turning pile and extended as the pile was used. Three steel stone skips were secured at a low price. To

charge the furnace, one of these was set on a small car and loaded with turnings, then run into the furnace room to the scales. An overhead hand operated traveling crane picked up the loaded skip with a chain sling and placed it over the loading platform where it was tripped and dumped. Handled in this manner, the entire charge was brought up in less than two hours. The turnings were forked into the furnace through the two charging doors.

The iron which was produced was cast into pigs. These were carried to an industrial car at the foot of the molding floor. The loaded car was run around the loop onto the scales. From here it was hauled up an incline to a platform level with the freight car door. The apparatus for pulling the car up the incline was nothing more than a winch with a cable attached to the end of the car. The winch was operated by an alternating current motor with a magnetic brake and hand control. It served the purpose in a satisfactory manner.

Tap Hole Opened With Arc

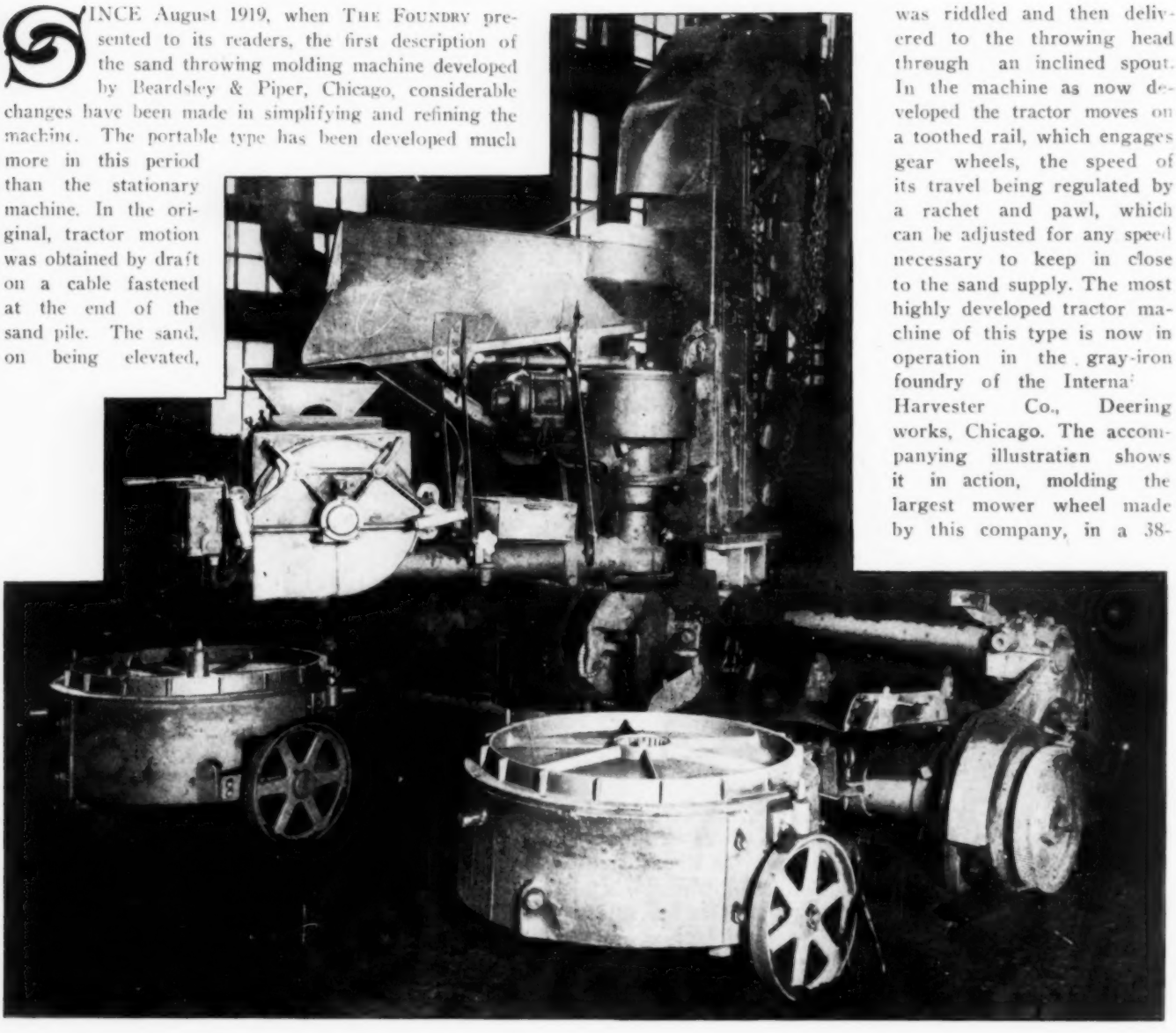
The great difficulty for the first month was tapping. The tap hole would freeze and if this did not happen, it would eat away so that the metal could not be held in the furnace. A number of times the tap hole had to be burned out. This was done with an arc. Two long steel bars were used for making the circuit. One was laid against the electrode holder and rested on a board on the floor. The furnaceman, standing on a board, held the other bar with one end at the tap hole and the side resting against the bar which touched the electrode holder. Then when the current was turned on an arc was formed at the end of the steel bar in the tap hole. This arc melted the frozen metal and opened the hole. It made a great noise and produced a considerable flashing but accomplished the job. Later, it was found that by plugging with common red clay dug up in the yard, no further trouble in tapping occurred, and the breast could be made to hold for two weeks at a time.

One ton for every hour was set for production, that is, 24-ton per 24-hour day. If this was exceeded the men were all paid an additional hour for every ton produced over the 24-ton schedule allotted to the shop.

Make Refinements in Sand Throwing Rig

BY. G. H. MANLOVE

SINCE August 1919, when THE FOUNDRY presented to its readers, the first description of the sand throwing molding machine developed by Beardsley & Piper, Chicago, considerable changes have been made in simplifying and refining the machine. The portable type has been developed much more in this period than the stationary machine. In the original, tractor motion was obtained by draft on a cable fastened at the end of the sand pile. The sand, on being elevated, was riddled and then delivered to the throwing head through an inclined spout. In the machine as now developed the tractor moves on a toothed rail, which engages gear wheels, the speed of its travel being regulated by a rachet and pawl, which can be adjusted for any speed necessary to keep in close to the sand supply. The most highly developed tractor machine of this type is now in operation in the gray-iron foundry of the International Harvester Co., Deering works, Chicago. The accompanying illustration shows it in action, molding the largest mower wheel made by this company, in a 38-



inch flask, with 6-inch cope and 6-inch drag. Patterns are mounted on stripping plates, the illustration showing both halves of the pattern following the machine. This tractor rams 7 cubic feet of sand per minute. Another machine now is being built which will handle 10 cubic feet per minute.

On this installation, the machine in one day handles a pile of sand 180 feet long, approximately 9 feet wide, and 20 inches deep. From this, a crew of five men, who have no other knowledge of molding than has been taught them on this job, put up 252 molds per day. The operation is more or less continuous, pouring being started about the middle of the forenoon and the flasks are used twice during each day.

The gear rails, on which the tractor travels, are set 9 feet, 6 inches apart, the sand being piled between them. A right and left screw conveyor carries the sand to the center where a bucket elevator lifts it to a point above the riddle into which it is discharged, scrap and other large particles being removed by the screen. The sand then falls into a hopper from which it is removed by an 8-inch belt, which conveys it horizontally to the sand throwing head, the sand being under motion when it reaches the head. Impetus to the stream of sand is given by a paddle shaped somewhat like a human hand, which moves at 1200 revolutions per minute. This paddle or clip is made of hard iron and friction by the sand wears it so that it must be replaced every few days.

In the illustration, the two patterns may be seen mounted on wheels and attached to the main shaft of the tractor, advancing as it moves down the sand pile, leaving the rows of completed molds in the rear. A pneumatic hoist is used for lifting the cope and drag. This is suspended from a crane which is towed by the tractor as it advances. This crane consists of two I-beams traversing a runway lengthwise of the foundry and mounted on these is a third I-beam moving across the axis of the shop. On the latter is a trolley from which the hoist is suspended. This gives wide range of motion for the hoist.

Flexibility due to the articulated joints of the arm carrying the sand throwing head makes it possible to reach a field represented by a semi-circle approximately 6 x 12 feet and makes possible the use of an unusually large pattern, two of medium size or four small patterns, insuring continuous operation in the latter cases, as one can be rammed while others are being prepared.

The tractor is moved and sand is elevated by a 7½-horsepower electric motor, while another of the same size supplies power for the head and the belt which supplies sand to the head. A 1-horsepower motor operates the riddle.

At the end of the day's run the entire tractor is picked up by the traveling crane and returned to the starting point for the next day. During the night the sand is cut and piled ready for the next day.

Although Beardsley & Piper first sold rights to large users to build machines of this type, they recently have formed a company to manufacture them for general sale. A plant has been established at 312 Union Park court, Chicago, where the machines are being made.

Book Review

Vocational Arithmetic, by C. E. Paddock and E. E. Holton; cloth; 232 pages, 4½ x 7 inches; published by D. Appleton & Co., and for sale by THE FOUNDRY price $2.00 net.

Intended to fill the needs for a practical arithmetic for the technical persons and the man in the shop, this book has been prepared by its authors to combine mathematical theories and a practical application of them to every day work. The usual branches of arithmetic are treated in a simple way in an attempt to make the book both entertaining and useful to those interested in shop carpentry, molding, patternmaking, and machine shop work. Besides the common operations in arithmetic as multiplication, subtraction, addition, and division, the book takes up cube and square roots, interest, measurements for pattern and foundry work, excavating, masonry, and carpentry, then explains the speed of pulley wheels and gives the ratio for toothed wheels.

Annealing Prevents Pulleys Cracking

By H. E. Diller

Question—We are sending you a pulley in which two spokes are cracked. A large percentage of our pulleys crack this way and we would like to know how to overcome it. We would also like to know how to run thin castings without losing so many through misruns.

Answer—We have received the pulley which you mention in your letter. This pulley was gated on two spokes near the rim and cracked where the spokes join the rim. This was due to the iron being fed through the spokes and keeping them hot until after the rim and center had set. You would get better results if you would gate the casting at the hub with a fairly large sized gate having a head. This would give a chance for the rim and spokes to set while the hub was still molten and being fed by the gates. The difficulty would be helped also by using a somewhat softer iron. We do not know the amount of silicon in your iron but notice that it is quite close-grained and that the edges are chilled. More silicon in the iron would overcome the chilling effect and would give an iron which would have slightly less contraction. These two changes should enable you to make the wheels without having them cracked at the spoke, but it might be advantageous to put the castings into a heated furnace as soon as possible after pouring them, and allow them to cool slowly in the furnace. This would remove internal strains and give you a stronger casting. The castings, however, should not be heated above 800 degrees Cent. in the anneal.

Your trouble in pouring your castings is probably due to the method you employ for melting. If properly melted without excessive ozidization you should have no difficulty in getting iron hot enough to run in castings you make. This has been conclusively proven by the automobile trade who run light section castings from low-phosphorus iron. Care should be taken to see that your coke bed is high enough and that you have enough coke between each charge. The grade of coke you are using should also be inspected to determine whether it is of a good quality.

Interstate Foundries Plans to Buy Other Plants

Several growing manufacturing plants will be purchased by the Interstate Foundries Corp., Boston, which recently was incorporated with a capital stock of $150,000. The company is not in a position now to make a statement concerning definite plans for the future, and is not planning to erect a plant, but contemplates purchasing several other plants, Rufus B. Delano, clerk for the company, states. Officers of the company are: President, Herbert Austin, Fall River, Mass.; treasurer, Junius P. Sokall, and clerk, Rufus B. Delano, both of Fall River.

Detroit a Stove Foundry Center

With an annual production of 600,000 stoves, ranges and furnaces, having a valuation of approximtely $15,000,000, Detroit continues to hold its rank as the greatest stove producing center in the world, according to a survey just completed by the Detroit board of commerce. This production is attained by five companies, Michigan Stove Co., Detroit Stove Works, Peninsular Stove Works, Art Stove Co., and Detroit Vapor Stove Co.

How to Make Bevel Gear Patterns

The Principles Involved in Laying Out Wheels with Involute and Cycloidal Teeth Together with Approved Methods for Constructing Patterns Are Described and Illustrated

BY JOSEPH HORNER

BEVEL gear patterns are considered more difficult to make than spur gears, because unless very great care is taken, the possibilities of error creeping in are numerous. This is due to the cone section which affects all the dimensions and details.

Spur and bevel teeth are shaped on the same principles, though on different projections. Both are related mathematically, since the teeth of spur gears are generated from rack teeth, and those of bevels from a crown gear, the teeth of which also are those of a rack. The involute and the cycloidal systems are both in use for pattern gears, but the first is supplanting the second. The diameter on which the tooth shapes are developed is not the real pitch diameter, that stated for meshing distance, but is one which is projected at a right angle with the pitch cone, Fig. 1. The number of teeth and their thickness is stated as on the pitch diameter; but their heights and curves are taken on the radii projected to the axial center lines. In the drawing shown the projection of the bevel wheel is equivalent to that of a much larger spur gear. The difference in the pinion is not nearly so large. Only in miters are both gears alike. There are two diameters, the major or outer one—the real pitch diameter, on which the tooth shapes and proportions are measured and the minor—the inner one on which these are controlled by the length which the tooth bears to the cone distance. The longer the teeth, the smaller of course will their proportions be on the inner diameter.

In Fig. 1, *A*, is the pitch diameter of the wheel and *B* is its projected radius. *C* is the pitch diameter of the pinion, and *D* its projected radius. *D* and *B* are drawn at right angles with the pitch cone *a-b* of the gears until they intersect the axes of revolution *b-c* of the wheel and *b-d* of the pinion. The teeth of the wheel are drawn on the projected radius *a-c*, as seen at the left, and those of the pinion on the radius *a-d*, also are drawn. The dimensions of the teeth on the inner face are obtained similarly, *e-f* the radius for the wheel, *e-g* that for the pinion. These are shown developed in their due relations to the major radii at the left. They also are shown as an alternative struck directly from *f*, and *g* at the right. The results are exactly alike. Three other cardinal elements are:—*h*, the angle which the pitch cone makes with the axis of the wheel in one case and of the pinion in the other; *j*, the angle of the roots of the teeth; and *k*, that of their points. These relations and also rim, and arm thicknesses, etc., are obtained by the patternmaker from a drawing made to actual size. The smaller wheel patterns are made with plated centers; those of moderate and large dimensions with arms,—four, six, or eight in number. Pinions are solid, save for the central core. In all cases except in those of the smallest pinion bodies are built up in segments or sectors. Pinions of not more than 5 inches or 6 inches in diameter can be turned in solid mahogany or pine, the grain running axially. Figs. 2 to 4 illustrate the stages of preparing the pattern rim for a bevel wheel, Figs. 2 and 3 showing a rim to which separate arms will be fitted, and Fig. 4 one with a plated center,—a disk, on which the rim is built. The same precautions are necessary in cutting these sector pieces as in those for spur gears. They may be neither very thick, nor very long; but dimensions must be kept within moderate limits in order to eliminate risk of shrinkages. Each course of segments differs in diameters from the others, and each must be wide enough to include the bevelled section of the rim. The first course is glued on the wooden face

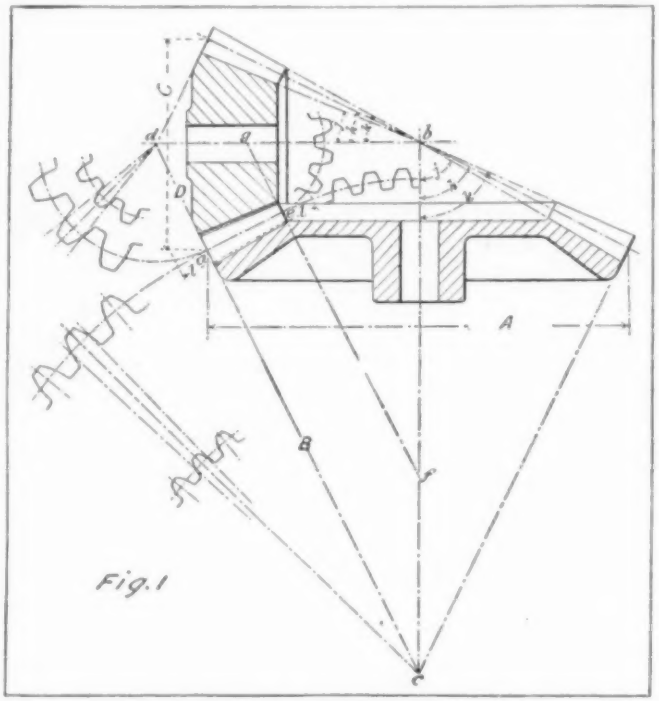
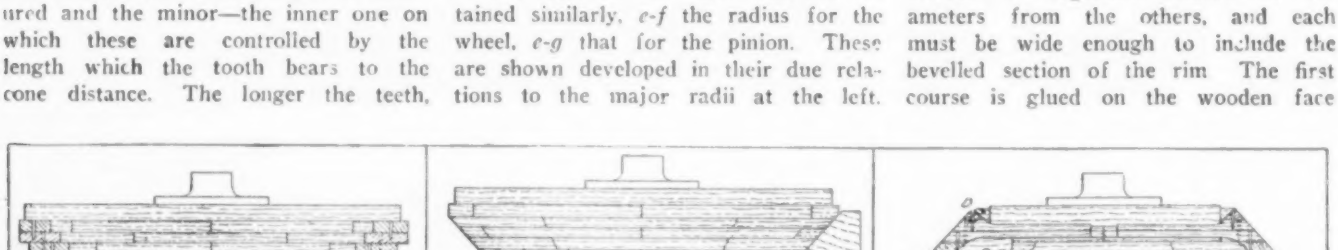


FIG. 1—METHOD OF LAYING OUT BEVEL GEARS BEFORE COMMENCING THE PATTERNS



FIGS. 2 AND 3 SHOW THE CONSTRUCTION OF A RIM TO WHICH SEPARATE ARMS WILL BE FITTED FIG. 4—A WHEEL WITH PLATED CENTER ON WHICH RIM WILL BE BUILT

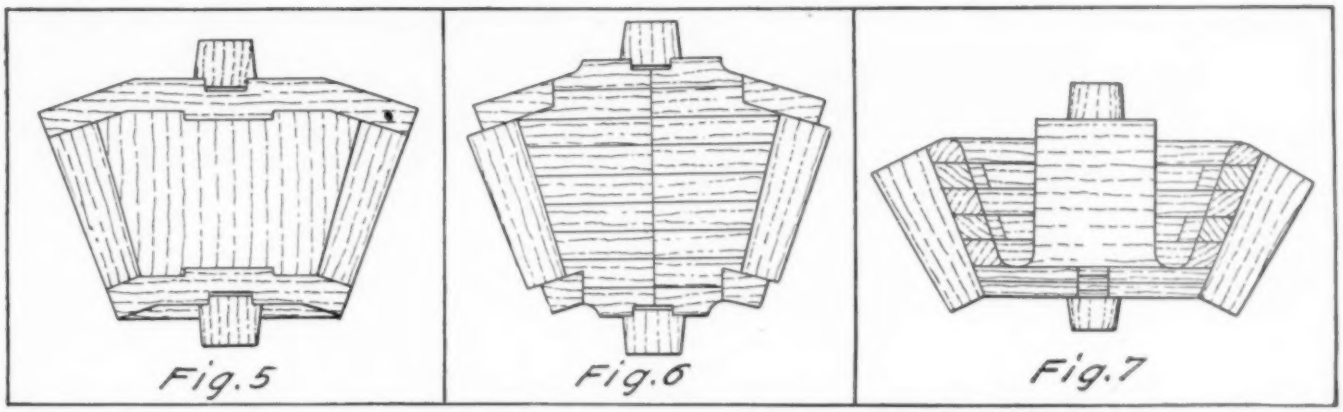


FIG. 5—PINION BODY TURNED OUT OF SOLID STUFF FIG. 6—THE PATTERN IS BUILT FROM A NUMBER OF SEGMENTS, USUALLY SIX TO THE CIRCLE FIG. 7—PINION PATTERN IN WHICH THE SPACE AROUND THE HUB IS HOLLOWED OUT

plate with paper joints which may be reinforced with a screw in each piece put in from behind, though this is not necessary if the glue is strong. Each course is faced in the lathe to receive the sectors of which the next is composed. The radius for each course is taken off the full size drawing.

Very often the glue alone is relied upon to retain the sectors permanently since they are reinforced by the attachment of the teeth. However, pegs afford a stand-by when patterns are standard, and taken in and out of the stores year after year. Nails are undesirable because of the bevelled section, against which some of them might come through. In Fig. 2 the rim has been built-up and pegged with the larger diameter outward, and laid aside for a few days to season, and for the glue to harden, after which it will be screwed to the face plate with the smaller diameter outward to have the rim turned for the attachment of the teeth. The back might be turned first, but it generally is better to begin with the front, because that is of most importance. How this is done is shown in Fig. 3.

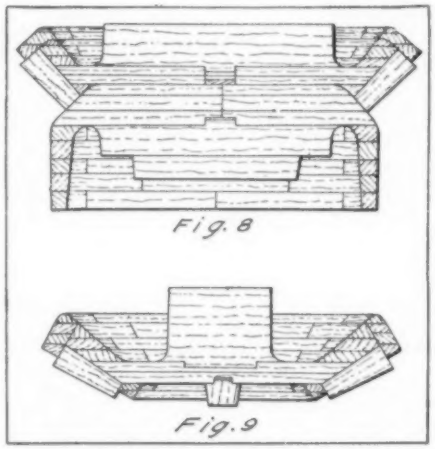


FIG. 8—PATTERNS WITH HALF SHROUDINGS BUILT UP RESPECTIVELY WITH THREE AND FOUR COURSES OF SECTOR PIECES—FIG. 9 ALSO SHOWS THE FITTING OF A CONE CLUTCH TO A BEVEL WHEEL

The front edge of the ring is faced, and the diameter for the roots of the teeth on that face is struck on it. Either a strip is bridged across the opening to receive a trammel point as a center from which to strike the radius, or the diameter is marked on the straightedge *A*, and transferred to the rim. Instead of attempting to get the larger diameter by direct measurement, a templet *B* is cut carefully, layed on the full size drawing, and applied between the edge of the straightedge and the rim. Alternatively *A* and *B* might be cut in one piece, but the straightedge must go right across the rim, and not abut on one narrow face. A line is struck around the rim about ⅛ inch away from the edge from which to raise a perpendicular for the teeth. The width of the rim is also struck as a guide for turning it at the second chucking.

Fig. 4 shows a rim with a plated center rechucked for turning the back. A hole bored in the center to receive bosses is fitted over a stud on the face plate. The edge of the rim is turned first, by the line just now mentioned, using the straightedge *A*, and the templet *B*. The thickness of the rim is then marked, and the interior turned by the templet *C*. If arms have to be fitted the interior of the rim is turned clear through, in which case it is located on the face plate in a vee'd recess to receive the portion *D* in Fig. 4. It is well but not necessary to complete the whole of the turning before fitting the teeth. Often the teeth are glued on the rim, before the back is turned.

Fitting the Teeth

The methods of fitting the teeth include all those described recently in connection with spur gear patterns. When the teeth taper very much, planing them in a templet box is not desirable because the dimensions at the smaller end of the box are so reduced that they afford little guide to the planes. The method would be suitable in the case of the gears shown in Fig. 1. The proportions and curves at the ends of the box are obtained by setting out suitable distances, as say, 1, 1, in Fig. 1, and by projecting the bevels of the teeth to those planes. The curves are developed, larger and smaller rspectively in the same way that the teeth are shown projected.

A dovetailed fitting is suitable, but tedious. The great advantage is that correct shapes can be imparted with planes, and that the teeth are pitched and their curves marked when in position. Alternative to this is the gluing on of cubical blocks to be marked in place, and shaped with chisel, gouge, and rebate plane. The blocks may be glued on the rim, or the rim can

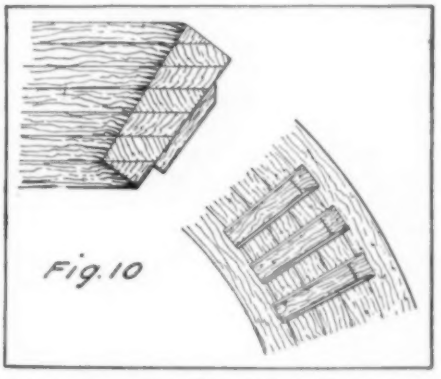


FIG. 10—HOW THE CORE PRINTS FOR A MORTISE WHEEL ARE FITTED

be turned down ⅛ inch or so below size and blocks be glued on wide enough to include three or four teeth with radii worked in their roots. These methods were illustrated in the recent articles on spur gears. The employment of fly cutters, suitable for the teeth of spur gears is open to the same objection as the use of milling cutters for bevel gears. The results are only approximately accurate and two cuts with different settings have to be made for each side of a tooth.

When fitting any tooth blocks, or finished teeth, a tee-square may be improvised, the stock being cut to fit around the outer rim, and the center

(Concluded on page 40)

THE FOUNDRY

Registered U. S. Patent Office

A semimonthly journal devoted to all branches of the foundry trade

Published by
THE PENTON PUBLISHING CO., CLEVELAND

BRANCH OFFICES

BOSTON....426 Old South Bldg.
CHICAGO....1147 Peoples Gas Bldg.
CINCINNATI....501-505 Commercial Tribune Bldg.
NEW YORK....2203-2206 St. Paul Bldg.
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WASHINGTON, D. C....40 Metzerott Bldg.

FOREIGN OFFICES

BIRMINGHAM, Eng....Prince's Chambers
LONDON, Eng....2-4 Caxton House, Westminster

Cable address, IROTRAPEN, London.

SUBSCRIPTION

United States and Mexico....$3.00 a year
Canada....$4.00 a year
Great Britain and other Foreign Countries....$5.00 a year
Single Copies....25 cents

Copies published three months or more previous to date of current issue, 50 cents each

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 1st and 15th of the month preceding date of publication

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Entered at the Post Office at Cleveland as Second Class Matter

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Casting Industry Calls the Physicist

MEANS must be provided for conducting metal into the mold in every case where a casting is to be made. There are many ways of varying this important step. The decision depends upon the man in charge of that particular work and will be influenced by his training. If he is a patternmaker he will look at it mainly from the angle of the patternmaker, and if he is a molder he will be able to see the molding advantages of the different gating methods. Much study usually is devoted to determining the best method for making the pattern, and great mechanical skill is displayed in rigging the molding equipment used. The foundryman in charge draws upon his mechanical knowledge gained from his daily experience with many varying patterns. He also develops a sort of instinct from his experience, which helps him to place the gates at the right place on the pattern and to make them the proper size. Ability in this direction never is appreciated so much as when experience is limited. Then lost castings mount to high percentages. This is especially true in malleable work, where an extremely hard metal with high contraction and internal shrinkage is poured. In one shop where casting losses were amounting to about 30 per cent they were brought to 12 per cent in two weeks, simply by changing gating methods in the most flagrantly defective jobs. Later the losses were lowered still further by studying and correcting the gating on all patterns. In another case, a foundry was having trouble in securing a reasonable percentage of good castings from a certain pattern and called in an expert. As soon as this experienced foundryman saw the pattern plate he detected the cause of the trouble, and after the gate was moved a half an inch from its original position the number of waster castings decreased. In both of these cases, the changes were made by practical foundrymen—men whose entire training had been in and about the foundry without any education along theoretical lines. These men utilized physical laws which they did not understand or ever know about. It is like walking in the dark to try to comply with laws which are not understood. One gets to his objective after receiving many bumps on the way, but each time he travels the path, he must grope no matter how much experience he has received through traveling the course many times. It would pay to turn on the light of physical science. The physicist trained in foundry operations could be of great benefit to the industry and could establish himself as a necessary adjunct to foundry operation, just as the metallurgical chemist already has found his niche. With foundry experience and a knowledge of physical laws of heat, contraction, shrinkage, cooling strains, etc., the physicist could familiarize himself with the essentials governing the proper gating of castings and eliminate much of the cut and try methods now employed. He also could elucidate the general laws governing the cooling of the castings so that the practical foundryman would become more familiar with the points to be observed in gating the pattern, just as he knows the effect of silicon on the metal without being a chemist or understanding chemical laws. Possibly as in the case of the foundry chemist comparatively few physicists would attain to the position of superintendent or manager of the foundry, but those who did reach this situation in the foundry industry would imprint their training on the whole field. Undoubtedly many would present papers showing advantages which they had secured through their specialized knowledge which could be adapted by the less technically trained superintendents.

Trade Outlook in the Foundry Industry

FOR the first time in many years, the holiday season was made the occasion for closing numerous foundries throughout the country for a period of two weeks or more. Some who have had a substantial backlog of orders to see them through a period of sixty to ninety days took this means to husband the work which they had in hand. Others used this opportunity to make a complete inventory, charging off in many instances a certain loss upon materials which they have in stock, prefering to have the deficit stand against profits shown earlier in the year and thus lower their tax levy.

Face Cost Problems

Those foundrymen who have come into contact with customers during the past few weeks have noted the tendency, which seems to extend through all industrial lines, to seek marked reductions in prices. Inquiries have appeared, prices have been quoted and these have been met by a comparison with the prices offered by other shops. Consumers are shopping about seeking price concessions. Foundrymen in general have no quarrel with this tendency, but it carries with it some perplexing problems. Most shops are stocked with high-priced materials which will be affected by present declines in the market. Labor, though plentiful in all sections, still remains at a high figure. High priced buildings and equipment have built an undue running interest charge, while city, county, state and federal taxes have to be met at higher rates. Freight upon materials is at top figure. In fact no single item of cost in the production of castings has dropped. The foundryman is confronted by the most difficult situation of selling below the actual cost of production if he meets the demands made by some of his customers. In periods of liquidation losses are absorbed by manufacturer, jobber and retailer alike, or at least this is the reaction which normally is experienced. Many foundries which have been caught with excessive stocks of iron have met the situation squarely and have resold metal and fuel at a lower figure, expecting in this way to protect themselves from greater loss.

Prices of Raw Materials for Foundry Use

CORRECTED TO DEC. 7

Iron		Scrap	
No. 2 Foundry, Valley	$38.00 to 39.25	Heavy melting steel, Valley	$16.00 to 16.50
No. 2 Southern, Birmingham	36.00 to 38.50	Heavy melting steel, Pittsburgh	15.00 to 16.00
No. 2 Foundry, Chicago	35.00 to 38.00	Heavy melting steel, Chicago	16.00 to 16.50
No. 2 Foundry, Philadelphia	35.00 to 36.00	Stove plate, Chicago	24.00 to 24.50
Basic, Valley	33.00	No. 1 cast, Chicago	21.00 to 21.50
Malleable, Chicago	35.00 to 38.50	No. 1 cast, Philadelphia	26.00 to 27.00
Malleable, Buffalo	35.00 to 36.00	No. 1 cast, Birmingham	26.00 to 28.00
Coke		Car wheels, iron, Pittsburgh	21.00 to 22.00
Connellsville foundry coke	$6.50 to 7.00	Car wheels, iron, Chicago	25.00 to 25.50
Wise county foundry coke	12.50	Railroad malleable, Chicago	17.00 to 17.50
		Agricultural malleable, Chicago	17.00 to 17.50

Stagnation Wide Spread

The processes of readjustment which are under way are affecting all sections and all branches of the castings industry alike. Gray iron jobbing shops which depend upon widely divergent manufacturing interests for their business are fast reaching the end of their orders. Stove foundries throughout the central west have felt a severe reaction within the past month, and just previous to Christmas most of them had inaugurated part time operation to conserve the work which they had at hand. Machine tool manufacturers report practically no inquiry and for that reason have sharply curtailed production. Cast-iron pipe makers have reduced prices, in some cases as much as 24 per cent, and many have practically no business in sight. Building trades are confronted with the worst slump since the armistice, and in consequence the demand for sanitary ware and domestic hardware is practically absent. Agricultural implements are a drug on the market, due to the sharp decline in prices for farm products and the inability of farmers to finance needed purchases. In the South, the cotton, tobacco and lumber situation has produced a complete stagnation that is strongly evident in its effect on the foundries of the Southern and Western sections. Coupled with these factors is the disinclination of the railroads to purchase any new equipment, holding orders in the hope of meeting lower prices. Malleable shops are operating below 50 per cent capacity. There probably is no parallel in industrial history for the present situation, but close approximations have been drawn through a comparison with economic conditions in the past. The very abruptness of the slump, coming as it does at the end of a period of prosperity, is fortunate, for it finds most of the manufacturing interests in better condition financially and in plant equipment and personnel to effect a quick recovery. Fundamentally the country is sound. There is a pent up demand for necessary commodities that must be met. Real wealth which includes the products of the farms, mines, forests, and factories is present in abundance. Labor and transportation facilities are ample to fabricate and deliver them, and the only factor which is at present missing is the inclination to exchange money for commodities. The most encouraging element, and the one which seems to foretell an early return of activity is the rapid decline in prices.

Nonferrous Inactive

Nonferrous casting plants are experiencing the same inactivity which characterizes other classes of the foundry industry, although the demand for electrical sundries and street railway equipment has had a stabilizing effect. Prices of nonferrous metals, based on New York quotations of Dec. 23 follow: Casting copper, 12.75c to 13.00c; lead, 4.50c to 4.75c; Straits tin, 32.00c to 32.50c; antimony, 5.25c; aluminum, No. 12 alloy, producers' price, 32.00c, and open market, 22.50c to 23.50c. Zinc is quoted at 5.60c to 5.70c, E. St. Louis.

Comings and Goings of Foundrymen

CHARLES B. WILSON, president and general manager of the Wilson Foundry & Machine Co., Pontiac, Mich., has been named vice president in charge of operation of the Willys-Overland Co., plants. Mr Wilson will be in charge of the Willys-Overland factories in Toledo, and Elyria, O., Elmira, N. Y., and Pontiac, Mich. Mr. Wilson has been directly and indirectly associated with the Overland organization and its interests during the past ten years. He has been prominently associated with the automotive industry since it became a factor in the industrial situation of this country, and his broad manufacturing knowledge has been acquired through practical experience. He was educated in the public schools, after which, as a machinists apprentice, he entered the shops of Webster, Camp & Low Co., Akron, O., manufacturer of Corliss and slide-valve engines, where he remained for about four years. He next was associated with Whitman & Barnes, Akron, O., manufacturers of small tools; and later with the Eastern Rubber Manufacturing Co., manufacturers of rubber goods, where he was engaged in designing and building special equipment and machines for manufacturing rubber goods. From there he went to the Harris Press Co., Niles, O., manufacturer of self-feeding automatic printing presses where, for two years, he was at the head of the experimental and development department. Leaving this work, Mr. Wilson became connected with the Diamond Match Co., Barberton, O., and remained for 18 months at the head of the machine shops of that company, where building labor saving machinery, was carried on. In 1898, he associated himself with the Olds Motor Works, Lansing, Mich., where, for eight years, he was works manager of that company's plants at Lansing, and Detroit, in which capacity he had extensive experience in experimental work and in building of stationary engines, gasoline motors and gasoline and electric motor cars. It was during this period that production work in automobile manufacture was inaugurated. During Mr. Wilson's association with the Olds company, he took the study of mechanical engineering. In 1906 he went to the Ferro Machine & Foundry Co., Cleveland, where, for eight years, he was vice president and general manager. He left this company in 1914 to organize the Wilson Foundry & Machine Co., of Pontiac, Mich., of which he has since been president and general manager. This company, under his management, has grown from a small enterprise to one of the largest gray iron foundries in the world, with a capacity for producing, machining and finishing daily, sufficient gray iron castings to supply 1500 automobiles. In joining the Overland organization, Mr. Wilson will continue to retain his title as president of the Wilson Foundry & Machine Co., but will relinquish the management to David R. Wilson, a brother, who is now vice president and sales manager, and who also, is well known throughout the automotive industry.

CHARLES B. WILSON

Pierre Baruzy, Paris, France, who has been studying the grinding industry at the Norton Co., Worcester, Mass., the past 18 months, has sailed for home, where he will be connected with the Norton Co.'s branch plant in LaoCurneuve, Seine, France. Mr. Baruzy is a noted French ace and is credited with bringing down four German airplanes during the war.

Arthur I. Fischer, manager, the Glauber Brass Mfg. Co., Cleveland, has been elected president of the Association of Brass Manufacturers.

A. O. Backert, vice president and general manager, the Penton Publishing Co., Cleveland, addressed the Detroit Foundry association at a meeting held Dec. 16, on "Signs of the Times."

Maj. R. A. Bull, foundry expert and consulting engineer, of Sewickley, Pa., who has been dangerously ill with pneumonia at Hotel La Salle, Chicago, has improved, having passed the crisis successfully.

J. H. Pennington has been made general manager of the McFarland Foundry & Machine Co., Trenton, N. J. Mr. Pennington formerly was with the Baltimore Copper Smelting & Rolling Co., Baltimore.

Isaac W. Frank, chairman of the United Engineering & Foundry Co., Pittsburgh, has been appointed as a member of the board of trustees at the University of Pittsburgh, and has assumed his duties.

Leon H. Johnson has resigned as general manager of the Anderson Foundry & Machine Co., Anderson, Ind., to become head of an engineering organization in Anderson, specializing on oil engine power plants.

Charles T. Topping, formerly of the Charles T. Topping Machinery Co., Pittsburgh, which has been associated with the Lakewood Engineering Co., Cleveland, has resigned to engage in the construction machinery business for himself.

C. H. Isreal has been appointed eastern representative of the Kingsford Foundry & Machine Works, Oswego, N. Y., with offices in Philadelphia. He formerly was works manager of the National Marine Engineering Works, Scranton, Pa.

John Campbell, secretary of the Flockhart Foundry Co., Newark, N. J., has resigned after 29 years of association with the company, and now is affiliated with the National Hoisting Engine Co., Harrison, N. J., founded 18 years ago by his brother, Colin Campbell. A dinner was given in honor of Mr. Campbell, at which he was presented with a gold watch and a diamond pin, by officers and employes of the Flockhart company.

Waddill Catchings, formerly president of the Central Foundry Co., New York, the Sloss-Sheffield Steel & Iron Co., and the Platt Iron Works, Dayton, O., has been appointed a lecturer at the Harvard Graduate School of Business Administration, Cambridge, Mass. In addition to giving lectures on the financing of industries, he will take part in the instruction in the school's new course on labor relation.

Charles Mack, who, until recently, was foundry superintendent in the American Foundry Co., Newark, N. J., has been placed in charge of the brass foundry department of the Westinghouse Electric & Mfg. Co., Essington,

Pa. Mr. Mack has been engaged in foundry work for 23 years, and for the past 18 years has been a foundry superintendnet.

Ethan Viall, editor-in-chief of the *American Machinist*, and for ten years a member of their staff, has resigned to become a member of the firm of T. W. Minton & Co., Barbourville, Kentucky, the largest producers of hickory dimension stock in the country. Previous to joining the staff of the *American Machinist*, Mr. Viall was for three years associate editor of *Machinery*, and before that he was for fourteen years foreman and superintendent in several of the largest specialty shops in the Middle West. During his shop career, he was a frequent contributor to THE FOUNDRY, and other magazines. He is a member of the American Society for Steel Treating, the American Welding Society, the American Society for Testing Materials, the American Society of Mechanical Engineers, the Society of Automotive Engineers and the American Institute of Electrical Engineers. He is author of Gas Torch and Thermit Welding, Electric Welding, Broaches and Broaching, and several books on munition manufacture, which were issued during the war.

Howard S. Van Billiard has been named general superintendent of the Rochester Castings Corp., recently incorporated with a capitalization of $2,000,000 for the manufacture of medium and light gray-iron castings. Mr. Van Billiard is a practical foundryman of long experience. He started as a foreman for the National Switch & Signal Co., Easton, Pa., in 1897. Later he joined the Ingersoll Sergeant Drill Co., as foreman, and in 1902 was made foundry superintendent for the Pneumatic Signal Co., then at Troy, N. Y. In 1903, when the company removed to Rochester, N. Y., started the foundry in the latter city, and continued as foundry superintendent, continuing in that capacity when the General Railway Signal Co., was formed to take over the Pneumatic Signal Co. Mr. Van Billiard resigned from the signal company last September to devote his attention to building and equipping the new plant. Production probably will be started in the spring.

H. Cole Estep, European manager, Penton Publishing Co., Cleveland, addressed a meeting of the Sheffield branch of the Institution of British Foundrymen, Nov. 19. Mr. Estep's paper, "American Foundry Practice", which was illustrated by lantern slides, depicted the most modern developments in casting manufacture.

Leon E. Thomas, newly elected president of the Eastern Pig Iron association for 1921, has been prominent in the iron and steel industry in the East. Mr Thomas was born in Pittsburgh in 1877, was graduated from the mechanical engineering course, Pennsylvania state college, in 1898, and received a degree of mechanical engineer in 1910. After a short time with Mackintosh, Hemphill & Co., Pittsburgh, he entered the engineering department of the Ohio Steel Co., at Youngstown, now the Ohio works of the Carnegie Steel Co. He left the Carnegie Steel Co., to become superintendent of the Youngstown plant of the United Engineering & Foundry Co., and after a year was transferred to that company's general office at Pittsburgh, where he remained

HOWARD S. VAN BILLIARD

until 1905. In 1905, Mr. Thomas became general manager of the Birdsboro Steel Foundry & Machine Co., and in 1916, was made vice president and general manager, which office he held until his election to the presidency of the Reading Iron Co., on March 15, 1919.

Philadelphia Foundrymen Hold Session

C. D. Trout, Air Reduction Sales Corp., Philadelphia, addressed the Philadelphia Foundrymen's association at the Manufacturers' club, that city, Dec. 8, on "Liquid Air," with a practical demonstration. J. F. Cooney, manager of the Kaustine Co., Inc., Real Estate Trust building, Philadelphia, spoke on "The Chemical Toilet Drainage System in Foundries and Machine Shops" where they are removed from the city sewerage area. Mr. Cooney's paper was illustrated with lantern slides.

Review Status of Electrical Melting

The use of electricity in the melting of metals is still in its infancy, according to F. J. Ryan, president of the American Metallurgical Corp., Philadelphia, in speaking before the December meeting of the New England Foundrymen's association at Boston recently. Mr. Ryan feels that advantage has not yet been taken of many of the important features of electricity in connection with melting and treatment of iron and nonferrous metals. From a strictly dollars and cents point of view, it is perhaps impracticable to melt iron electrically in foundries in the majority of cases where this metal is melted. The speaker stated that where accurate heat control is desired, the advantage of an electric furnace is so pronounced as to make any difference in cost of operation negligible. Up to the present time the largest electric furnace in operation is one of 75 tons but there are two 125-ton electric furnaces under construction for the United States Steel Corp., and the tendency is undoubtedly toward larger units in electric melting and heat treating. Mr. Ryan outlined the development of the furnaces up to the present time, and showed illustrations of existing installations. The meeting was well attended and Mr. Ryan's paper was followed by a lively discussion, centering more particularly on the problems of foundrymen. Brass foundries come clearly within the field of electric melting in its present stage of development, according to the speaker, but in gray iron foundries, electricity is advisable only for auxiliary purposes. Electric core ovens were said to be remarkably efficient and satisfactory in operation.

Book Review

MacRae's Blue Book; cloth, 1855 pages, 8 x 11 inches; published by MacRae's Blue Book Co. Railway exchange; and for sale by THE FOUNDRY; price $10, postpaid.

This book, which is the 1920 edition of the yearly directory, is a thoroughly indexed listing of over 30,000 American manufacturers. The names are cross indexed to assist the user One listing contains in alphabetical order the names and addresses of the manufacturers, even showing in many cases, the location of branch offices. A second listing shows indexed under 10,000 classifications of material, the names and addresses of the various manufacturers of railway supplies, iron and steel products and building and construction material.

A third and convenient indexing is an alphabetical arrangement of trade

names of materials and the names and addresses of the manufacturers. The first 300 pages of the book is a catalog section consisting of condensed catalogs of various manufacturers. Following the trade name index is a section of miscellaneous data, such as weights, measures and tables secured from many sources. The standard list price section appearing at the end of the book is a special copyright feature in which are listed and indexed standard list prices on commodities in common use by railroads and industrial concerns.

Welding Society Formed

A Cleveland section of the American Welding Society was organized at a meeting held in the rooms of the Electrical League, Statler Hotel, Cleveland, Dec. 1. Other sections of the organization, which has its headquarters at 33 West 39th street, New York city now are in existence in New York, Pittsburgh, Philadelphia and Chicago.

How to Make Bevel Gear Pattern

(*Concluded from page 35*)

lines being marked across the rim by an edge of the blade. Another way is to carry over lines in two or three places by the geometrical method of raising a perpendicular, for which a line was mentioned as having been struck round the rim.

When rough tooth blocks are fitted, either with dovetails, or glued directly, they are sawn large enough to allow for turning the tops and both ends. This is done with templets made from the full size drawing. The small ends are turned first then the tops of the teeth using a templet like that in Fig. 3. The large ends, not necessarily at a second chucking, can be checked with a templet worked from the tops of the teeth, just done. The pitch lines, and lines of centers from which the tooth curves have to be described are struck while the work is running in the lathe. The teeth are pitched on the large diameter first, and the pitches are carried over in three, or four places to the minor diameter, using the geometrical method, on the outer ends, the tops, and the smaller ends. The tooth thicknesses are then set out on each side of the pitch points, and the curves are struck from the line of centers.

The arms are a weak element in the patterns of bevel gears, since they cannot be sunk very well into the rim like those of spurs. A plated center like that in Fig 4 is a stronger form; but that is not suitable for large wheels. Arms are fitted within the bevelled ring, abutting against its slope, and secured with fine screws driven in diagonally. They are reinforced with large flanking radii, glued in. If the rim has an internal flange, a better job can be made, since the arms can be let into it for half their thickness, and be glued and screwed. No help is afforded by the presence of vertical ribs, since they must be left loose to come away in the scope if the mold is not to be torn up by the lifting off of the top box part. The usual way is to center the boss with a stud, sink the vertical ribs into it for a little distance and keep them in the center of the flat arms with dowels. In the smaller wheels the vertical arms frequently are omitted, the boss being studded loosely in a plated center.

Figs. 5 to 7 illustrate pinion constructions. Fig. 5 is one in which the body is turned of solid stuff, the grain running axially in order that any slight shrinkage effects shall take place equally, which would not be the case if the patterns were cut *plank-way*. The teeth are prepared separately, but some of the smaliest patterns have them cut solidly with the body. The method of fitting full shrouding is shown, the shrouds being turned from solid stuff, and fitted with studs to the body. The prints also are studded to interchange for bores of different sizes.

Fig. 6 is a pattern built up with segments, of say, six to the circle, with the grain running radially so that no shrinkage can occur diametrically. Half shroudings are shown, fitted as rings, also cut in the solid, a method only suitable for those of small dimensions because of shrinkage effects. Fig. 7 is a plated pinion, having a studded back boss without arms.

Fig. 8 and 9 illustrate patterns with half-shroudings built up respectively with three and four courses of sector pieces. The sectors must be thin and not long, since there should never be less than three thicknesses. The rings are made loose and independent, to permit of delivery. They have to be turned with the aid of templets in two chuckings like wheel rims. Fig. 8 also shows the fitting of a cone clutch to a bevel wheel, it is built up and studded loosely.

Fig. 10 shows how the core prints for a mortise wheel are fitted. The upper ends are chamfered for delivery, and the core box is formed similarly, so that the cores *stop themselves off*.

The Blue Ridge Talc Co., Inc., Henry, Va., recently has installed a new pulverizer at the plant of the Franklin Soapstone Products Corp., which was purchased last May.

Obituary

William M. Fitzpatrick, a pioneer salesman of foundry supplies and equipment, died at his home, Reading, Pa., Wednesday, Dec. 8. Mr. Fitzpatrick at the time of his death was affiliated with the S. Obermayer Co., Chicago, and he was in the employ of this company continuously for a period of 33 years. With headquarters at Pittsburgh and latterly at Reading, Mr. Fitzpatrick represented the Obermayer Co. in central and western Pennsylvania and throughout this section he enjoyed a wide acquaintance among casting manufacturers. Surviving are his widow, Sallie A. Fitzpatrick, and one son, William H., of New York City. Three sisters remain: Katherine Fitzpatrick, and Mayme, wife of Dr. E. H. Bainbridge, both of Philadelphia, and Mrs. George Gregg, of Burlington.

Grain Closed Without Chilling the Iron

By H. E. Diller

Question—We operate a foundry manufacturing castings for transformers, crankcases, machine tools, etc. Included in our product are thread miller beds which resemble the bed of a lathe. The iron in these beds is too open to take a smooth finish on the ways, and we would appreciate any suggestion as to the best means to get close grained iron in the beds. We want to avoid the use of steel in our mixture if possible.

Answer—The meager data you give does not fully determine your best course. It is not possible to tell whether the iron you are making is too soft even for your transformers, crankcases and other castings. It is possible that you could use a harder, closer-grained iron for all your castings and thus secure a close-grained iron that will take a proper finish in your bed. Sulphur increases the wearing properties of iron and some foundries that make cylinders, use iron with sulphur as high as 0.16 per cent. If you raise the sulphur content nearly to this figure, it would be of assistance in giving a satisfactory iron for bed plates. Thin-sectioned chills, just heavy enough to close the grain without chilling the iron, would give the metal desired if placed in the mold forming the ways of the beds.

You say that you wish to avoid the use of steel in your mixture, if possible, but we see no objection in any way to using 12 per cent steel in the mixture, and it would be of assistance to you in getting a strong, close-grained iron.

December Marks Low Ebb in Inquiry

Foundry Equipment Sales Are Light as Foundries Await Price Stabalization to Bring Return of Orders — New Construction Held Back

DECEMBER probably will set a new low level for sales of foundry equipment, when compared with the preceding eighteen months. Paralysis in the castings industry has effectively blocked most of the contemplated new plant construction and replacement buying has been at a low point. Some inquiry is noted in the eastern and middle western states, but most of this is contingent upon conditions after the first of the year. An interesting development is the appearance of active German competition for export trade in foundry supplies. German competition which has been noted in the South American trade for some time, recently has been evidenced through bidding on machinery for use by American owned companies abroad. Equipment manufacturers have adopted part time operation of their plants in step with similar conditions in the foundry industry.

German Competition Appears in Export

THAT Germany is putting up formidable competition in the export field for foundry equipment is indicated by bids now being submitted to the Standard Oil Co., 26 Broadway, New York City, which is in the market for complete machinery for a foundry to be erected in Roumania. The German bids, it is said, are fully 25 per cent under those submitted by domestic manufacturers, and adding to the attractiveness of the foreign proposals is the fact that the shipping charges from Germany to Roumania would be considerably smaller than from this country.

Another foreign job which appears at this time as being lost by American manufacturers of foundry supplies is that of the Tata Iron & Steel Co., Sakchi, India, involving about $15,000 worth of equipment. Perin & Marshall, 2 Rector street, New York City, representatives of the Tata company, have withdrawn the inquiry. However, this has not been due to outside competition, but rather to the fact that the company has at least temporarily abandoned the plan of erecting a new foundry.

While the situation generally throughout the East is quiet, sellers of foundry equipment report considerable business pending. At the same time, there are several new projects coming up, which undoubtedly result in buying. The Baltimore Car & Foundry Co., Baltimore, has completed plans for an addition, which will cost, not including the equipment, about $20,000. The West Bridgewater Foundry Co., West Bridgewater, Mass., is to build an addition, and the Florence Pipe Foundry & Machine Co., Florence, N. J., a $10,000 pattern shop. The Jamestown Malleable Products Co., Jamestown, N. Y., is in the market for an electric overhead crane and some miscellaneous foundry equipment.

Curtailment Reacts on Equipment

CURTAILMENT of operations among foundries in the Pittsburgh and nearby districts is having a deterrent effect upon the demand for foundry equipment. The only orders are from foundrymen who are taking advantage of the present lull to make necessary repairs and to place their equipment in operating condition. F. J. Ryan & Co., Franklin Trust Bldg., Philadelphia, are constructing a large 12-drawer electric core oven for the Thos. Devlin Mfg. Co., Philadelphia, to be installed at the latter's Burlington, N. J., malleable iron plant. The Blystone Mfg. Co., Cambridge Springs, Pa., during the past month has installed sand mixing machinery in the following plants: P. B. Yates Machine Co., Beloit, Wis.; Miami Foundry Co., Miamisburg, O.; Federal Malleable Co., West Allis, Wis., California Mortar Co., Berkeley, Cal.; McMyler Interstate Co., Bedford, O. The latter purchased two units.

Little Inquiry in Chicago District

FOUNDRY equipment inquiry in the Chicago district is light. Foundries are curtailing operations and in many cases shutting down. This has shortened demand for supplies and materials and has extinguished desire for additional equipment. Some founders are looking further into the future than the present situation and are laying plans for betterments and additions, but most of these plans are in the formative stage. A molding machine manufacturer with an unusual product is busy to the capacity of his plant on orders booked some time ago but is not taking new business at the moment. New foundry equipment and supplies will be purchasedaa by T. A. Parey, 917 Conwell street, Connersville, Ind., for the new plant he is building in that city. Increasing its capital stock from $500,000 to $800,000, the Wagner Mfg. Co., Sidney, O., is adding a new aluminum foundry and polishing, cleaning and assembling departments. The improvements being made by this company will require considerable foundry equipment, power transmission apparatus and electrical machinery.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The plant of the Golden Foundry & Machine Co., Golden, Ill., recently was damaged by fire.

Foundry alterations will be made by the Creswell Iron Works, Philadelphia.

The American Engineering Co., Philadelphia, plans alterations and improvements to its foundry building.

Capitalized at $25,000, the Kittaning Foundry Co., Pittsburgh, recently was incorporated by J. W. King, F. R. Edmunds, Kittaning, Pa., and C. Magill.

The La Velle Foundry Co., Indianapolis, has a permit for the erection of a foundry building.

The plant of the Gote Foundry, Evansville, Ind., recently was damaged by fire.

The Central Foundry Co., Mt. Union, Pa., has deferred until after the first of the year, work on the erection of a new plant building.

The plant of the Portsmouth Metal & Foundry Corp., King and Louisa streets, Norfolk, Va., recently was damaged by fire. It will be rebuilt.

For the purpose of keeping pace with the growth and development of its business, the Sivyer Steel

Casting Co., Milwaukee, has increased its capital stock from $400,000 to $800,000.

The Haskel & Barker Car Co., Chicago, plans the erection of a 1-story power plant and foundry addition.

The Pyott Foundry Co., 328 North Sangamon street, Chicago, has started work on alterations and improvements to its foundry.

Capitalized at $100,000, the Converse Foundries Co., Canton, O., recently was incorporated by C. M. Converse J. J. Hutmacher and others.

The H. J. Hunter Brass Co., Cleveland, recently was incorporated with a capital stock of $30,000, by R. H. Hunter, J. W. Smith, and others.

The River Smelting & Refining Co., Cleveland, recently was incorporated with a capital stock of $30,000, by C. Rosenblatt, H. H. Finkle, and others.

The Thomas Special Flux Co., Cleveland, recently was incorporated with a capital stock of $3000, by H. L. Dycke, H. Thomas, and others.

The foundry at the plant of the Superior Gas Engine Co., Springfield, O., recently was damaged by fire.

The Wheeling Axle Co., Wheeling, W. Va., has applied for a permit for the erection of a foundry building.

The Chester Iron & Foundry Co., 7000 Vulcan street, St. Louis, plans the erection of a foundry building and power plant, 50 x 100 feet.

The West Bridgewater Foundry Co., West Bridgewater, Mass., is reported planning the erection of two additions to its plant.

The Utica Valve & Fixture Co., Utica, N. Y., contemplates the erection of a valve manufacturing plant.

The Florence Pipe Foundry & Machine Co., Florence, N. J., plans the erection of a pattern shop building, 1-story, 50 x 100 feet.

A $20,000 plant extension will be made to the plant of the Baltimore Car & Foundry Co., Baltimore. There will be two buildings, each 1-story high.

The John A. Belvin estate, Richmond, Va., care of H. S. Taylor, 18 North Ninth street, that city, plans repairs to its foundry.

The Pioneer Brass Works, 424 South Pennsylvania avenue, Indianapolis, has completed plans for the erection of a 2-story plant building, 75 x 175 feet.

The buildings, plans and equipment of the Electro Foundries, Ltd., Orilia, Ont., recently were damaged by fire.

Plans are being prepared for the erection of an addition to its plant, by the Gibson & Kirk Co., 211 Key highway, Baltimore. The building will be used as a foundry.

Bloch Brass Co., New York, recently was incorporated with a capital stock of $55,000, by J. R. Courtney, R. B. Quincy and E. C. Schroeder, 62 East Thirty-fourth street.

Plans are being prepared for rebuilding the section of the plant of the May Foundry Co., Sixty-first and Eastwick avenue, Philadelphia, which was recently damaged by fire.

The Newark Foundry Co., Newark, N. J., recently was incorporated with a capital stock of $250,000, by Eugene Edwards, M. C. Wright and Oliver T. Taylor.

The Mt. Vernon Furnace & Mfg. Co., Belleville, Ill., recently was incorporated with a capital stock of $75,000, by Carl Schwennwirth, A. B. Ward and C. T. Mullen.

The City Brass Works Co., 1742 Carroll avenue, Chicago, recently was incorporated with a capital stock of $50,000, by Arthur Tausch, A. Grosskopf and Peter Cedarstrom.

The Modern Pattern Works, Indianapolis, has been incorporated to manufacture patterns and operate a foundry with a capital stock of $20,000, by John Emminger Jr., Julius Kelly and E. E. Sluss.

Capitalized at $1,500,000, the Stewart Furnace Co., Mentor, O., recently was incorporated by H. Andrews, J. S. Brumback, G. B. Houseman, T. J. Mills and S. B. Pearce.

Charles Froelich, Inc., Troy, N. Y., recently was incorporated with a capital stock of $10,000, to make stoves, furnaces, etc., by F. C. Filley, A. V. and C. Froelich.

Amendments have been filed to the articles of incorporation of the Northwestern Malleable Iron Co., 756 Park street, Milwaukee, providing for an increase in the authorized capitalization from $500,000 to $1,200,000.

The Grand Rapids Foundry Co., Grand Rapids, Wis., is erecting an addition to its plant, 50 x 104 feet, to be used as a pattern shop and storage vault. Space released in the present machine shop will be used for additional machinery now being purchased.

Plans are being prepared by an architect at Cincinnati, for the erection of an addition to the plant of the Michael's Art Bronze Co., 230 Scott street, Covington, Ky. The building will be 4-stories and cost about $40,000.

The Murphy Pressure Flushing Trap Co., Ltd., Hull, Que., has been incorporated to carry on business as brass and iron founders, etc., with a capital stock of $50,000, by Robert N. Murphy, Ottawa, Ont., O. A. Archambault and John E. C. Elliot.

An increase in the capital stock of the A. J. Lindemann & Hoverson Co., Milwaukee, from $500,000 to $1,000,000, recently was made. The company, which is a large manufacturer of stoves, ranges and heaters, recently completed the erection of plant additions and a number of improvements.

The Somerville Iron Foundry Co., 88 Washington street, Somerville, Mass., has advised that work has practically been completed on an addition to its plant. This building will be used for storage purposes only and no additional machinery and equipment will be needed.

By increasing its capital stock from $500,000 to $800,000, the Wagner Mfg. Co., Sidney, O., will finance the erection of a new aluminum foundry and polishing and cleaning departments. The company will require considerable foundry equipment, power transmission apparatus and electrical machinery.

Wilcox, Crittenden & Co., Inc., Middletown, Conn., has advised that it has settled on the design, construction and engineers for its proposed foundry building, but that work on the structure will not be started before next spring or summer, depending upon conditions in the labor and material markets.

The Great West Smelting & Refining Co., Forty-first and Wallace streets, Chicago, has been incorporated with a capital stock of $47,500,000, to buy, sell and manufacture in metals, etc., by David Blum, Ivan Ritter and Z. Lippe. The company will take over the business of the Great Western Smelting & Refining Co.

To manufacture and deal in foundry supplies is the purpose of the Mac Co., Milwaukee, which was recently organized by W. J. Adams, formerly of the S. Obermayer Co., Chicago, John R. Cumings, formerly of the same organization, and a number of others prominent in the trade. The company has opened a plant at Thirty-fourth and National avenues, West Milwaukee, where it is manufacturing parting, plumbago, core oil and similar materials.

Sarachan & Rosenthal, Inc., Rochester, N. Y., producers of red and yellow brass ingots, are completing the erection of a new smelting plant. In addition to a battery of coke furnaces, electric furnaces of large capacity will be installed to make possible the production of a large tonnage of high grade ingots. The new plant is to be of brick and steel construction and will be equipped with all modern appliances.

The plant of the Williams Mfg. Co., Ltd., 1789 St. James street, Montreal, Que., in liquidation, will be offered for sale. The complete plant, which is now in operation, consists of a 5-story machine shop, 50 x 100 feet; 4-story machine shop, 40 x 187 feet; 2-story woodworking shop, 50 x 78 feet; gray iron foundry, 70 x 176 feet and a 2-story office building. Complete machine tool equipment, including electric motors, transmission and shafting will be sold either with the plant or separate.

Several plant buildings to be erected on a 5-acre site in Toronto, when completed will be occupied by the Crouse-Hinds Co. of Canada, Ltd.; the Harvey Hubbell Co of Canada, Ltd., and the Hubbell-Mack Machine Screw Co., Ltd. The main building will be 80 x 500 feet, either three or four stories; there will also be a foundry, 60 x 300 feet and a pattern storage building, 2-stories, 100 x 100 feet. It is the intention to have the buildings completed and machinery and equipment installed by November, 1921.

Capitalized at $100,000 the Charles R. Hilb Metals & Smelting Co., Cincinnati, recently was organized with Charles R. Hilb, as president. The company will carry on smelting and refining in red and white metals of all kinds, drosses by-products and will sell all grades of nonferrous metals. The exact location of the company's plant will be announced later. It will be 1-story and cover approximately 25,000 square feet. Mr. Hilb was secretary and general manager of the Hilb Smelting & Refining Co., Cincinnati, for five years, joining that organization nine years ago. Other officers of the new company are D. E. Smith, secretary, and L. C. Hilb, vice president.

Several growing plants will be purchased by the Interstate Foundry Corp., 60 Pemberton square, Boston, which was recently incorporated with a capital stock of $150,000. R. B. Delano, in behalf of the company, has advised that as yet the company is not in a position to make a definite statement concerning its future, but advises that at the present time it does not plan to erect a plant, but contemplates purchasing several going plants. He adds that the company has already received offers of several properties. Officers of the company are: President, Herbert Austin, Box 259, Fall River, Mass.; treasurer, J. P. Sokoll, 27 Purchase street, Fall River, and clerk, R. B. Delano, same address.

New Trade Publications

JOLT TABLE—The American Foundry Equipment Co., New York, is circulating a 4-page illustrated leaflet in which an electric toggle jolt table, for ramming or packing foundry sand and other substances, is described and illustrated.

MOLDING MACHINE—An electric jolt, rollover, squeeze, pattern-draw molding machine is described and illustrated in a bulletin recently published by the American Foundry Equipment Co., New York.

OXYACETYLENE TORCH—The Air Reduction Sales Co., New York, is circulating a newly published booklet, attractively illustrated, containing a reprint of a paper on "Cutting Cast Iron with the Oxyacetylene Torch," which was prepared by A. S. Klusey, Stevens Institute of Technology, and presented at the recent meeting of the American Foundrymen's association. The treatise completely covers the subject of cutting cast iron with the oxyacetylene flame. It tells how the cut is made, gives necessary pressures of oxygen and acetylene for varying thicknesses of metal, and a number of other details.

JACKS—The Duff Mfg. Co., Pittsburgh, is distributing a new 148-page illustrated catalog, in which its complete line of lifting jacks is described and illustrated. The jacks described, include those for service on railroads, in the automotive and industrial world, and range from 1 to 75 tons in lifting capacity.

WELDING REPAIRS—The Metal & Thermit Corp., New York, has recently issued a small instruction booklet, No. 41, which was expressly prepared for use by men performing welding railroad repairs. The pamphlet is of pocket size and the instructions have been condensed into the smallest possible space.